STAR

DECEMBER 23, 1967

VOLUME 5 • NUMBER 24

N67-39382—N67-40600

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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Scientific and Technical Aerospace Reports, Volume 5, is prepared by the NASA Scientific and Technical Information Facility operated for the National Aeronautics and Space Administration by Documentation Incorporated.

Use of funds for printing this publication approved by the Director of the Bureau of the Budget June 7, 1966.

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02 AIRCRAFT
Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics. **4373**

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Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants. **4393**

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Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation. **4402**

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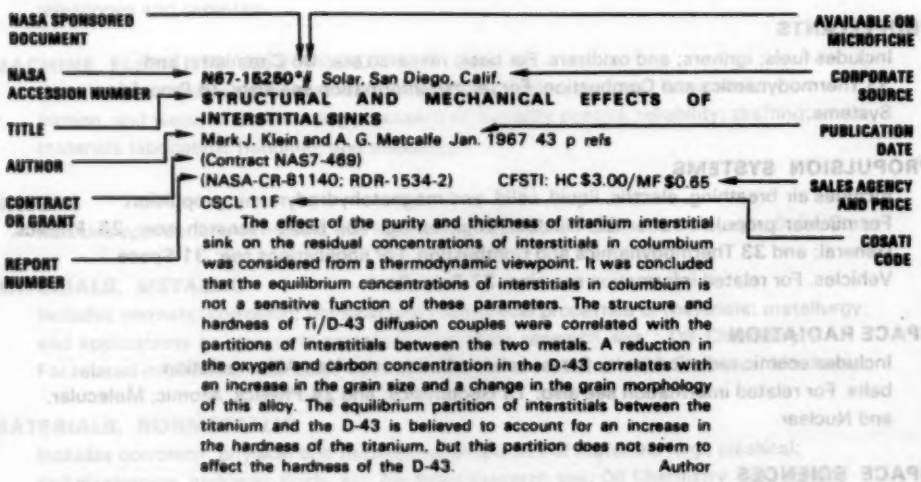
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STRUCTURAL AND MECHANICAL EFFECTS OF INTERSTITIAL SINKS
PUBLICATION DATE
AUTHOR
Mark J. Klein and A. G. Metcalfe Jan. 1967 43 p refs
(Contract NAS7-469)
CONTRACT OR GRANT
(NASA-CR-81140; RDR-1534-2) CFSTI: HC $3.00/MF $0.65
SALES AGENCY AND PRICE
CSCL 11F
COSATI CODE
REPORT NUMBER
The effect of the purity and thickness of titanium interstitial sink on the residual concentrations of interstitials in columbium was considered from a thermodynamic viewpoint. It was concluded that the equilibrium concentrations of interstitials in columbium is not a sensitive function of these parameters. The structure and hardness of Ti/D-43 diffusion couples were correlated with the partitions of interstitials between the two metals. A reduction in the oxygen and carbon concentration in the D-43 correlates with an increase in the grain size and a change in the grain morphology of this alloy. The equilibrium partition of interstitials between the titanium and the D-43 is believed to account for an increase in the hardness of the titanium, but this partition does not seem to affect the hardness of the D-43. Author

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Scientific and Technical Aerospace Reports

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01 AERODYNAMICS

Includes aerodynamics of bodies, combinations, internal flow in ducts and turbo machinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion.

N67-39385# Fluidyne Engineering Corp., Minneapolis, Minn.
EFFECTS OF ABLATION ON THE PITCHING MOMENT DERIVATIVES OF CONES IN HYPERSONIC FLOW
Shukry K. Ibrahim 4 Apr. 1967 107 p refs
(Contract Nonr-4624(00); ARPA Order 576)
(Rept.-0414-4-4-67; AD-658345)

The work presents a method of calculating the static and dynamic pitching moment derivatives at hypersonic speeds for pointed or slightly blunted cones performing small-amplitude, single-degree-of-freedom oscillations about an arbitrary pivotal axis, taking into account the effects of ablation or blowing over all or specified portions of the cone surface. The study is motivated by the need for detailed understanding of the large destabilizing changes in the pitching oscillations sometimes observed on re-entry vehicle test flights. In the analysis, the ablation gases leaving the body are assumed to produce the following two-fold effect: (1) A deflection of the external flow which produces a change in the local static pressure coefficient readily calculated by the Newtonian flow theory and (2) a change in the local skin-friction coefficient. Author (TAB)

N67-39608# RAND Corp., Santa Monica, Calif.
ON CONCAVE BODIES IN FREE MOLECULE FLOW
R. Schamberg Aug. 1967 35 p refs
(P-3164-1; AD-658013)

Data on drag of concave surfaces are represented. Unshielded concave surfaces are considered, for which the entire surface is exposed to the incident free molecule flow. The effect on free molecule drag of shielding a portion of the concave surface from the incident flow is illustrated. From a practical point of view, free molecule flow over concave bodies is of interest for possible applications including parachute-like drogue devices, high altitude air collectors or induction systems for propulsion systems, pressure probes, etc. TAB

N67-39670# FluiDyne Engineering Corp., Minneapolis, Minn.
WIND TUNNEL TESTS EMPLOYING TEMPORAL AND SPATIAL VARIATIONS IN MASS TRANSFER DISTRIBUTION THROUGH A CONICAL SURFACE TO CONTROL AERODYNAMIC PITCHING MOMENT CHARACTERISTICS
Final Technical Report, 31 Jan.–31 Mar. 1967
S. K. Ibrahim, K. W. Smith, R. B. Pollock, and C. D. Christopherson
31 Mar. 1967 92 p refs
(Contract Nonr-4624(00); ARPA Order 576)
(Rept.-0414-3-31-67; AD-658344)

A unique apparatus was created which permits the support of a conical model in a hypersonic wind tunnel with small pitch damping due to the apparatus, and at the same time provides a means for blowing through four separate (aft, forward, top, bottom combinations) model surface areas. Tests were made without mass transfer, with mass transfer produced by a subliming material, and with mass transfer produced by blowing through a porous surface. These tests provided additional confirmation that mass transfer from a surface will, in itself, significantly influence the pitch damping characteristics of a conical shape, whether its origin is in a heat transfer related phenomenon (such as ablation or sublimation) or an independently controlled flow process such as is represented by blowing through the conical surface. In addition, these tests provided an opportunity for shakedown of the blowing flow control apparatus; however, it was not possible to carry the blowing study into the parametric investigation initially planned. Author (TAB)

N67-39673*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
DETERMINATION OF AERODYNAMIC DAMPING COEFFICIENTS FROM WIND-TUNNEL FREE-FLIGHT TRAJECTORIES OF NON-AXISYMMETRIC BODIES
R. H. Prislin and M. B. Wilson 15 Oct. 1967 39 p refs
(Contract NAS7-100)
(NASA-CR-89566; JPL-TR-32-1159) CFSTI: HC $3.00/MF $0.65
CSCL 01A

General formulas for estimating the aerodynamic damping coefficient from planar free-flight oscillation histories are presented. Using Jaffe's energy–integral equation (a phase plane integral of the motion), systematic approximations are introduced that lead to the derivation of accurate results for highly nonlinear and asymmetric static aerodynamics. Particular attention has been given to making the results valid, even for large initial amplitudes and for extreme asymmetries. Two examples are presented to demonstrate the accuracies involved with the various approximations and to illustrate the computational procedure needed for actual data reduction. Author

N67-39787# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
THE EFFECT OF INCLINATION ON THE STROUHAL NUMBER AND OTHER WAKE PROPERTIES OF CIRCULAR CYLINDERS AT SUBCRITICAL REYNOLDS NUMBERS
J. Surry and D. Surry Aug. 1967 49 p refs
(Contract AF 33(615)-2305)
(UTIAS-TN-116; AD-657779)

A brief experimental investigation was made to determine the effect of inclination on the Strouhal Number of circular cylinders at Reynolds numbers from 4,000 to 65,000. It was found that

the Strouhal Number based on the normal velocity component remained constant to a good approximation. Spectral techniques showed that the energy of the shed vortices dispersed in frequency and decreased in significance with increasing inclination, such that for angles less than 40 degrees the shedding energy was negligible compared to the general wake turbulence energy, at 7.5 diameters downstream from the cylinder. Other wake properties were briefly investigated. These included the decay of the u-component of turbulence downstream and the behaviour of the wake spectra with inclination, speed and wake location. Author (TAB)

N67-39881# ARO, Inc., Arnold Air Force Station, Tenn.
EFFECTS OF ROLL ON THE FREE-FLIGHT MOTION OF STATICALLY STABLE BODIES Final Report
C. J. Welsh and R. M. Watt Arnold Eng. Develop. Center, Sep. 1967 31 p refs
(Contract AF 40(600)-1200)
(AEDC-TR-67-156; AD-658433)

The effects of roll on the free-flight yawing motion of statically stable test models, having linear force and moment characteristics, are discussed in more detail than in previous publications. The correspondence between the damping, frequency, and amplitude of the nutational and precessional vectors which define the motion is listed. Limitations in the use of simplified data reduction procedures when the model motion is monitored in only one plane are pointed out, and cases of pseudo-nonlinear characteristics being exhibited by the orthogonal components of the yawing motion of a rolling motion are demonstrated. Author (TAB)

N67-40001 Tokyo Univ. (Japan). Inst. of Space and Aeronautical Science.
LIFTING-LINE THEORY FOR CASCADE OF BLADES IN SUBSONIC SHEAR FLOW
Masanobu Namba and Tsuyoshi Asanuma Aug. 1967 49 p
(ISAS-415, Vol. 32, no. 8)

A theory of lifting-lines for cascade of blades in subsonic shear flow is developed by assuming that the dependence of the local lift force upon the local upstream Mach number in shear flow is same as that in two-dimensional flow. By comparing theoretical results with experimental ones, the physical validity of the present theory is discussed. The effect of compressibility upon the mean characteristics of a cascade is found to depend upon the root of harmonic mean square of upstream Mach number ($\overline{M}^*_\infty$). Experimental correlation is satisfactory as far as $\overline{M}^*_\infty$ of the shear flow lies below a certain limit value, and this limit value corresponds to the two-dimensional Mach number beyond which the small disturbance theory for two-dimensional cascade shows poor validity. Significance of $\overline{M}^*_\infty$ as a criterion for the mean characteristics is also confirmed experimentally. Author

N67-40121*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
STUDIES OF OPTIMUM BODY SHAPES AT HYPERSONIC SPEEDS
Louis S. Stivers, Jr. and Bernard Spencer, Jr. (Langley Res. Center) Washington, NASA, Oct. 1967 16 p refs Presented at the NASA Conf. on Hypersonic Aircraft Technol., Ames Res. Center, Moffett Field, Calif., 16–18 May 1967
(NASA-TN-D-4191) CFSTI: HC $3.00/MF $0.65 CSCL 01A

The present study was directed toward the questions that arise in the application of optimum bodies to the design of hypersonic cruse aircraft. The considerations were divided into two parts. The first involved the calculated minimum-drag characteristics of four families of slender bodies for Mach numbers from 2 to 12. The second concerned the experimental evaluation of the effects of body cross-sectional shape on the aerodynamic performance of bodies at a Mach number of 10. The constraints in each study were body length and volume, although the constant values are different in each part of the study. Author

N67-40150*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SUBSONIC AND SUPERSONIC FLUTTER ANALYSIS OF A HIGHLY TAPERED SWEPT-WING PLANFORM, INCLUDING EFFECTS OF DENSITY VARIATION AND FINITE WING THICKNESS, AND COMPARISON WITH EXPERIMENTS
E. Carson Yates, Jr. Washington, NASA, Nov. 1967 71 p refs Supersedes NASA-MT-X-764
(NASA-TN-D-4230; NASA-TM-X-764) CFSTI: HC $3.00/MF $0.65 CSCL 01C

The flutter characteristics of several wings with an aspect ratio of 4.0, a taper ratio of 0.2, and a quarter-chord sweepback of 45° have been investigated analytically for Mach numbers up to 2.0. Results indicated that: (1) Flutter speeds were accurately predicted by the modified strip analysis, although accuracy at the highest Mach numbers required the use of nonlinear aerodynamic theory for the calculation of the aerodynamic parameters. (2) An abrupt increase of flutter-speed coefficient with increasing Mach number, observed experimentally in the transonic range, was also indicated by the modified strip analysis. (3) In the low supersonic range for some densities, a discontinuous variation of flutter frequency with Mach number was indicated by the modified strip analysis. An abrupt change of frequency appeared experimentally in the transonic range. (4) Differences in flutter-speed-coefficient levels obtained from tests at low supersonic Mach numbers in two wind tunnels were also predicted by the modified strip analysis and were shown to be caused primarily by differences in mass ratio. (5) Flutter speeds calculated by the subsonic-kernel-function method were in good agreement with experiment and with the results of the modified strip analysis. (6) Flutter speeds obtained from piston theory and from quasi-steady second-order theory were higher than experimental values by at least 38 percent. Author

N67-40208# David Taylor Model Basin, Washington, D. C. Aerodynamics Lab.
THE STATIC AERODYNAMIC CHARACTERISTICS OF A VARIABLE SWEEP WING RESEARCH MODEL
John M. Durkin and David G. Lee Mar. 1967 64 p ref
(DTMB-AL-38; AD-658498)

A wind tunnel study was conducted to determine the effect of Mach number, angle of attack, and wing sweep angle on the longitudinal aerodynamic characteristics of a variable sweep wing research model. The study was conducted at Mach numbers between 0.60 and 1.15 and at angles of attack from -2 to 16 degrees. The report presents the data for the static phase of the investigation. Author (TAB)

N67-40254 Royal Aircraft Establishment, Farnborough (England).
GUIDED WEAPONS AERODYNAMIC STUDY: THE EFFECT OF FOREBODY LENGTH OF THE LONGITUDINAL STABILITY OF TWO DELTA-WING–BODY COMBINATIONS OF WING ASPECT RATIO 1.03 AND 0.31 AT MACH NUMBERS UP TO 2.8
E. F. Lawlor Oct. 1966 45 p refs
(RAE-TR-66327)

Wind tunnel force and moment measurements have been made on a wing-body configuration having lengths of parallel forebody of 0.254 and 2.254 calibers ahead of wings of aspect ratio 1.03, and on a configuration having lengths of 0.317 and 3.317 calibers ahead of wings of aspect ratio 0.31. All configurations had an ogival-type nose of fineness ratio 3. The Reynolds number of the tests was 0.62×10^6 based on the body diameter of 3.7

in. The results show that lengthening the parallel part of the forebody had little effect on overall normal force, but caused a positive change in pitching moment and hence was destabilizing. A comparison of estimated and experimental results at zero roll shows that the normal force and center of pressure position can be predicted quite well. Author

N67-40325# National Research Council of Canada, Ottawa (Ontario).
QUARTERLY BULLETIN OF THE DIVISION OF MECHANICAL ENGINEERING AND THE NATIONAL AERONAUTICAL ESTABLISHMENT, 1 APRIL-30 JUNE 1967
30 Jun. 1967 104 p refs
(DME/NAE-1967(2)) CFSTI HC $3.00/MF $0.65

The results of three research projects are summarized which deal with measurements of mountain waves and mountain wave turbulence using the T-33 aircraft, a review of screening principles and methods, and measurements made in vortex wakes behind a DC-8 aircraft. Also included are brief descriptions of several current projects being conducted in the areas of computer analysis, control systems, engines, flight research, fuels and lubricants, gas dynamics, high speed aerodynamics, hydraulics, instruments, low speed aerodynamics, low temperature research, ships, structures and materials, and unsteady aerodynamics. R.N.A.

02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

N67-39391# Lightning and Transients Research Inst., Minneapolis, Minn.
AIRFLOW VELOCITY EFFECTS ON LIGHTNING IGNITION OF AIRCRAFT FUEL VENT EFFLUX Final Report
M. M. Newman, J. R. Stahmann, and J. D. Robb Washington, FAA, Jul. 1967 33 p refs Prepared in cooperation with Atlantic Res. Corp.
(Contract FA-66-WA-1486)
(DS-67-9)

Studies of the effects of airflow, at aircraft holding velocities up to 250 knots, over the surface of an aircraft singtip containing a recessed fuel vent showed that the probability of lightning ignition of the fuel vent efflux was greatly reduced by the airflow. From almost certain ignition with no airflow and the optimum fuel flow rate and mixture obtainable, the ignition frequency dropped to one in 34 shots with 50 knots airflow, one in 31 shots at 90 knots, none in 200 shots at 200 knots and non in 10 shots at 250 knots. Streamering at the recessed fuel vent studied, due to a five megavolt surge, did not produce ignition, even with no airflow. However, with swept strokes the ignition frequencies were greatly increased to six in 8 shots at 100 knots and two in 36 shots at 200 knots. This result demonstrates that a swept stroke could be most hazadous. Very high flame speeds, of the order of 1,000 feet per second, have been measured. The lightning blast wave and the air stream effects appear to increase the flame speeds. Author

N67-39504# Army Board for Aviation Accident Research, Fort Rucker, Ala.
INJURY EXPERIENCE IN ARMY HELICOPTER ACCIDENTS
Kenneth L. Mattox [1967] 8 p refs
(HF-68-1; AD-658079)

The gross pattern of injury--site, frequency and seriousness--in U. S. Army helicopter accidents is shown. Although 95 percent of the major helicopter accidents are survivable, 22 percent of the deaths in all helicopter accidents occur in survivable conditions. The mechanisms of these avoidable deaths are discussed as well as the steps that should be taken to reduce the morbidity and mortality rate. Author (TAB)

N67-39617# ARO, Inc., Arnold Air Force Station, Tenn.
A REVIEW OF JET EFFLUX STUDIES APPLICABLE TO V/STOL AIRCRAFT
Jack E. Garner Arnold Eng. Develop. Center, Sep. 1967 17 p refs
(Contract AF 40(600)-1200)
(AEDC-TR-67-163; AD-658432)

The state-of-the-art of jets exhausting into a subsonic crossflow is presented. These studies complement the current research effort in development of an analytical description of the flow field created by a V/STOL aircraft. Author (TAB)

N67-39719*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
PRELIMINARY EVALUATION OF XB-70 AIRPLANE ENCOUNTERS WITH HIGH-ALTITUDE TURBULENCE
Eldon E. Kordes and Betty J. Love Washington, NASA, Oct. 1967 22 p refs
(NASA-TN-D-4209) CFSTI: HC $3.00/MF $0.65 CSCL 01B

Measurements of airplane response to clear-air turbulence were obtained during supersonic flights of the XB-70 airplanes to an altitude of 74,000 feet. In general, the results for 75,757 miles of operation above 40,000 feet altitude show that turbulence was encountered on an average of 7.2 percent of the miles flown between 40,000 feet and 65,000 feet and an average of 3.3 percent of the miles flown above 65,000 feet with less than 1 percent of the turbulent areas exceeding 100 miles in length. Power-spectral-density estimates of the acceleration response to turbulence show that the structural modes contribute an appreciable amount of the total response. Author

N67-39738# Litton Systems, Inc., Woodland Hills, Calif. Guidance and Control Systems Div.
INTEGRATED COCKPIT RESEARCH PROGRAM. APPENDIX II Final Report
John V. Murphy, Donald J. Pizzicara, James J. Belcher, Robert L. Hanson, and Raymond E. Benberg 1 Jan. 1967 93 p
(Contract Nonr-4951(00))
(AD-658754)

The Integrated Cockpit Research Program was designed to develop a methodology for avionic system design application to aircraft in an advanced time period. Emphasis was placed on two major activities. One was concerned with identifying the requirements for the operator/avionic system in the future time period, and a second activity was concerned with identifying the technological state-of-the-art that would be available in the advanced time period to meet those requirements. Successive aspects of the study were concerned with synthesizing an avionic system, completing a cost effectiveness evaluation, and the preparation of a cockpit mockup. Appendix II contains the data processing analysis with block diagrams of the major functional areas. Author (TAB)

N67-39741# Air Force Flight Test Center, Edwards AFB, Calif.
THE REPORT OF THE AD HOC COMMITTEE ON VSTOL TERMINOLOGY Final Report
Robin K. Ransone and Joseph G. Basquez Jul. 1967 17 p
(AFFTC-SP-67-1001; AD-658545)

The report is a standardized list of definitions associated with Vertical Short Takeoff and Landing aircraft. Contributions were made from among the several military services and aircraft companies. Author (TAB)

N67-39863# Federal Aviation Agency, Oklahoma City, Okla. Office of Aviation Medicine.
AN EVALUATION OF POTENTIAL DECOMPRESSION HAZARDS IN SMALL PRESSURIZED AIRCRAFT
John J. Swearingen Jun. 1967 14 p refs
(AM-67-14) CFSTI: HC $3.00/MF $0.65

Over 300 decompression tests have been conducted to determine potential hazards of ejection or incapacitating or fatal head injuries in small volume pressurized aircraft in the event of sudden decompression following the loss of a window, emergency exit, door or windshield. Evaluations were made to determine the relationships of cabin volume (100 to 700 cu. ft.), window area (100 to 900 sq. in.), pressure differential (5 to 9 psi), body weight and size (13 to 180 lbs.) and relative distance from the opening in terms of ejection and head impact injuries. Summary graphs and charts are presented showing which test configurations resulted in ejections or dangerous head impacts. Author

N67-39888# Air Force Systems Command, Wright-Patterson AFB, Ohio. Aerospace Medical Research Labs.
EVALUATION OF NOISE PROBLEMS ANTICIPATED WITH FUTURE VTOL AIRCRAFT
John N. Cole and Robert T. England May 1967 24 p refs
(AMRL-TR-66-245; AD-658448)

The potential noise problems anticipated with future VTOL aircraft are analyzed and discussed in general terms, and a brief review of the basic principles of noise generation of various types of propulsion systems proposed for VTOL is included. Primary consideration is given to the noise environments produced in areas adjacent to VTOL sites, since they could cause the most serious noise problem limiting the usefulness of VTOL aircraft. Contours of perceived noise levels are compared for different takeoff and landing profiles of 3-4 passenger, 60 passenger, and 25 ton-lift-crane VTOL aircraft. Criteria and methods for assessing the response of communities to noise from V-port operations are discussed along with the problem of detection of military VTOL aircraft by means of noise. Recommendations are given on the requirements for future research on these noise problems with emphasis on the need for considering noise as an integral part of the design, selection, and test of VTOL aircraft. Author (TAB)

N67-39980*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
LONGITUDINAL AERODYNAMIC CHARACTERISTICS IN GROUND EFFECT OF A LARGE-SCALE, V/STOL MODEL WITH FOUR TILTING DUCTED FANS ARRANGED IN A DUAL TANDEM CONFIGURATION
Demo J. Giulianetti, James C. Biggers, and Ralph L. Maki Washington, NASA, Oct. 1967 30 p ref
(NASA-TN-D-41 (NASA-TN-D-4218) CSCL 01C

Measurements were made at three ground heights for duct incidence settings required for airspeeds ranging from hover to cruise. Forward speed, fuselage angle of attack, and duct exit vane deflection were varied. The model had favorable ground effects on lift at hover. For test conditions representing STOL operation, the ground effects on lift varied from favorable to adverse to no effect for duct incidences of 70°, 50°, and less than 30°, respectively. Longitudinal stability varied with approaching ground such that reverse control inputs would be required for trim. Author

N67-39996 Technisch Documentatie en Informatie Centrum Voor de Krijgsmacht, the Hague (Netherlands).
BIBLIOGRAPHY ON AIRCRAFT NOISE, SUPPLEMENT II, SEPTEMBER 1958–SEPTEMBER 1966
C. J. de Ruig May 1967 62 p refs
(TDCIK-5350-SII)

Abstracts on the following subjects: Noise from Aircraft; Helicopters and Hovercrafts; Airport Noise; Acoustical Fatigue; Theoretical and Design Aspects; Measurement of Noise; Reduction of Aircraft Noise; and Protection of People. Author

N67-40015 Royal Aircraft Establishment, Farnborough, (England).
FLIGHT TESTS OF A TREFOIL PARACHUTE ASSEMBLY FOR THE LOW LEVEL DELIVERY OF PARATROOPS
G. A. Podevin Jan. 1967 48 p
(RAE-TR-67017) CFSTI: HC $3.00/MF $0.65

The Trefoil parachute system is a three canopy assembly and can be described as a duplicated system with a built-in reserve devise to cater for the low level aspect of paratrooping. Tests are described which were carried out on this assembly, and it is concluded from the results that it is suitable for the task. Its main attributes are its reliability, its high stability during flight, and its resistance to dragging a man in high surface winds after landing. Author (ESRO)

N67-40102*# National Aeronautics and Space Administration. Langley Research Center, Cleveland, Ohio.
WIND-TUNNEL BUFFETING MEASUREMENTS ON TWO WING END-PLATE AIRPLANE MODEL CONFIGURATIONS
William B. Igoe Washington, NASA, Oct. 1967 29 p refs
(NASA-TM-X-1454) CFSTI: HC $3.00/MF $0.65 CSCL 01C

During the course of wind-tunnel force tests on a 1/30-scale model of a proposed subsonic nuclear-powered airplane in the Langley 16-foot transonic tunnel, wing-buffeting measurements were made on two different wing–end plate model configurations. The low-aspect-ratio (3.8) wing had a leading-edge sweepback angle of 51°, and the high-aspect-ratio (6.0) wing had a leading-edge sweepback angle of 36°. The model support system introduced undesirable buffeting response vibration modes in the same frequency range as the model wing vibration modes. On a comparative basis, the high-aspect-ratio wing configuration generally exhibited a more abrupt entry into buffeting with increasing angle of attack and had a lower lift coefficient for the onset of buffeting than that of the low-aspect-ratio wing configuration. Author

N67-40116# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
A STUDY OF THE EFFECTS OF CI-COUPLING ON THE LATERAL STABILITY OF AIRCRAFT IN ATMOSPHERIC TURBULENCE
E. Ryerson Case Sep. 1967 54 p refs
(Contract AF 33(615)-2305)
(UTIAS-TN-118) CFSTI: HC $3.00/MF $0.65

The effect of a C_L-coupling phenomenon on aircraft lateral stability is studied by means of an analog simulation of flight through atmospheric turbulence. No instability is observed in control-fixed flight, and the increase in gust response which results from the coupling effect is found to be effectively reduced by introducing synthetic roll stiffness. Correlated side and vertical gust components are considered, as well as an equilibrium side–slip condition. Both high-aspect-ratio swept-wing and slender delta-wing jet transports are examined. Author

N67-40198*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

LARGE-SCALE WIND-TUNNEL INVESTIGATION OF A V/STOL TRANSPORT MODEL WITH WING-MOUNTED LIFT FANS AND FUSELAGE-MOUNTED LIFT-CRUISE ENGINES FOR PROPULSION

Jerry V. Kirk, Brent K. Hodder, and Leo P. Hall Washington, NASA, Nov. 1967 88 p refs

(NASA-TN-D-4233) CFSTI: HC$3.00/MF$0.65 CSCL 01C

The low-speed aerodynamic characteristics of a large-scale fan-in-wing V/STOL transport model were investigated. The model had six fans mounted in the wing and two lift-cruise engines mounted forward of the wing in the fuselage. The high mounted wing had an aspect ratio of 3.43, taper ratio of 0.47, and a sweepback at the quarter chord line of 20°. Combinations of two, four, and six fans were investigated as well as the chordwise position of the fans in the wing to determine the interference effects of the fan flow field on the airframe flow field. The effects of operating two lift cruise engines forward of the wing in conjunction with the six lift fans were also studied. The complete configuration with six fans operating and with the fans and lift-cruise engines operating had generally acceptable aerodynamic characteristics. Author

N67-40232# Litton Systems, Inc., Woodland Hills, Calif. Guidance and Control Systems Div.

INTEGRATED COCKPIT RESEARCH PROGRAM, APPENDIX I Final Report

John V. Murphy, Donald J. Pizzicara, James J. Belcher, Robert L. Hamson, and Raymond E. Bernberg Jan. 1967 249 p

(Contract Nonr-4951(00))

(AD-658753)

The Integrated Cockpit Research Program was designed to develop a methodology for avionic system design application to aircraft in an advanced time period. Emphasis was placed on two major activities. One was concerned with identifying the requirements for the operator/avionic system in the future time period, and a second activity was concerned with identifying the technological state-of-the-art that would be available in the advanced time period to meet those requirements. Successive aspects of the study were concerned with synthesizing an avionic system, completing a cost effectiveness evaluation, and the preparation of a cockpit mockup. Appendix I contains the function flow diagrams and the matrix analyses for all three missions. Author (TAB)

N67-40253 Royal Aircraft Establishment, Farnborough (England).

CABIN CONDITIONING TESTS ON A SIMULATED M 2.2 TRANSPORT AIRCRAFT CABIN

T. L. Hughes and E. A. Timby Apr. 1966 122 p refs

(RAE-TR-66118)

This report describes tests made to investigate a cabin insulation scheme and to determine cooling air distribution requirements for a supersonic (M 2.2) passenger transport aircraft. Thermal conditions of flight were simulated in a ground rig with a section of aircraft fuselage equipped as a cabin. Several methods of introducing air into the cabin were tested. That employing the principle of jet entrainment was found to be the most economical in cooling air mass flow, to provide overall passenger thermal comfort. The insulation and cooling scheme for the cabin wall was evaluated and the amount of heat leakage in the test specimen established. Author

N67-40431*# Hydronautics, Inc., Laurel, Md.

AN ANALYSIS OF PERFORMANCE ESTIMATION METHODS FOR AIRCRAFT

Clinton E. Brown and Chuan Fang Chen Washington, NASA, Nov. 1967 59 p refs

(Contract NAS1-5816)

(NASA-CR-921) CFSTI: HC$3.00/MF$0.65 CSCL 01C

A study has been made of the various measurements and analytical extrapolations which affect the prediction of full scale flight performance from wind tunnel tests of geometrically scaled down models. The effects considered include wind tunnel measurements and calibrations, measurements of viscous shear forces at widely varying Reynolds numbers, interference forces between engine installations and airframe, and various sources of drag not usually found in model testing. The general result of the analysis is that the rms accuracy of prediction of drag at full scale can be better than 3 percent at design cruise conditions when currently available techniques for testing are used. Methods of in-flight thrust prediction and measurement lead to the conclusion that a 68 percent probability exits that properly executed wind tunnel drag predictions and calculated drag values from well instrumented flight tests should agree within 5 percent. Author

N67-40528*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

AERONAUTICS IN REVIEW: AVIATION IN HISTORICAL PERSPECTIVE

James F. Connors Washington, NASA, 1967 57 p refs Presented to the Lewis Aerospace Explorers, Cleveland, 30 Sep. 1967

(NASA-TM-X-52354) CFSTI: HC$3.00 CSCL 01B

The development of the airplane and its interrelation with the needs of the military are briefly reviewed. The real prelude to manned powered flight is considered to be the glider school. Highlights are described for the periods of pre-Wright, the Wright era, World War I, between the wars, World War II, and post-World War II. The shifts in the engine, wing, and structural designs are mentioned. Extensive photographs from the glider stage through the variable sweep wing transports of the future are included. N.E.N.

03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

N67-39388* Naval Ammunition Depot, Crane, Ind. Quality Evaluation Lab.

EVALUATION PROGRAM FOR SECONDARY SPACECRAFT CELLS ACCEPTANCE TEST OF SONOTONE CORPORATION 20 AMPERE-HOUR SEALED NICKEL-CADMIUM CELLS

28 Aug. 1967 23 p

(NASA Order W-112523)

(NASA-CR-89536; QE/C-67-562) CSCL 10C

Results of tests to determine the effect of mechanical pressure on cell plates of nickel-cadmium cells are presented. Half of the cells were used as controls and the others had the same construction plus prings to give constant mechanical pressure normal to the face of the nickel-cadmium stack. The test conditions are described, and the data are tabulated and graphed. It was considered that the sealing technique used to secure the pressure relief valves to the covers may be a problem area. It was determined that the mechanical pressure on the cell stacks makes no appriciable difference on initial capacities. N.E.N.

N67-39390* General Electric Co., Waynesboro, Va. Specialty Control Dept.
POWER CONDITIONER FOR EXPERIMENTAL MODEL SERT II ION THRUSTOR Final Report
P. D. Corey 17 May 1967 98 p
(Contract NAS3-7939)
(NASA-CR-72179; TD-5699) CSCL 10B

Circuits and ion thrustor ground-test hardware for efficient, reliable, potentially lightweight power conditioning were successfully developed. A single breadboard, two rack-mounted models, and a dummy load were built and delivered. Tests were run with a mercury ion thrustor. After a 50-hour endurance run one engine and power conditioner were committed to a life-testing program. This power conditioning system is suitable for flight packaging and mission application. Author

N67-39400*# Thermo Electron Engineering Corp., Waltham, Mass.
APPLIED THERMIONIC RESEARCH Quarterly Progress Report, 25 Jan.–25 Mar. 1965
S. Kitrilakis, S. Lieb, F. Rufeh, and L. van Someren 25 Mar. 1965 96 p refs Prepared for JPL
(Contract NAS7-100)
(NASA-CR-98493; TE82-66; QPR-3) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Diagnostic testing of a converter with CsF for the electronegative surface additive effects resulted in evidence that water contained in the CsF was responsible for the additive effects. The CsF was therefore purified to permit the determination of its effect on the work function of tungsten at thermionic temperatures, and the work function changes were determined to be about 0.1 eV. The thermodynamic equilibrium of oxygen in the converter environment was analyzed, and it was concluded that the oxygen pressure required for coverage was chemically compatible with the environment near the collector. A critical experiment using oxygen under steady state conditions indicated the emitter work function and power output closely resembled those of the CsF devices. Argon plasma additives were also studied, and results verified the hypothesis that the saturation portion of the ignited mode is diffusion dominated. In the evaluation of the ion conservation capabilities of argon, a two-fold improvement was found in the performance of etched rhenium over polished rhenium, and the etched emitter gave the same performance at twice the spacing required by the polished emitters. N.E.N.

N67-39412*# Marquardt Corp., Van Nuys, Calif.
HYPERGOLIC ENGINE SPACE POWER SYSTEM VOLUME I: TECHNICAL
11 Mar. 1965 54 p
(Contract NAS9-857)
(NASA-CR-89538) CFSTI: HC $3.00/MF $0.65 CSCL 10B

A program is proposed to demonstrate the operation of the present hypergolic space power unit on gaseous hydrogen and oxygen. The existing components and test facilities will be utilized whereever possible. The major problems are indentified as utilization of the hypergolic injection mechanism, monitoring and control of gas flow, method of ignition, and selection of injection sequences. The present engine, engine parts, and engine systems, and the proposed modifications are discussed and analyzed. The program plan and management are outlined, and the test facility subsystem is described. N.E.N.

N67-39447# Pratt and Whitney Aircraft, East Hartford, Conn.
DESULFURIZATION OF LIQUID HYDROCARBON FUEL FOR FUEL CELLS Final Technical Report, 10 Jan. 1966–10 Apr. 1967
Herbert Setzer and Arthur Kaufman 25 Apr. 1967 47 p refs
(Contract DA-44-009-AMC-1446(T))
(PWA-3087; AD-657685)

An experimental evaluation of catalytic guard chamber materials and systems studies were made to select a desulfurization technique and guard chamber catalyst-absorbent. Certain supported nickel catalysts were found effective in the removal of organic sulfur compounds from feed mixtures of fuel and water. The addition of hydrogen to the feed was found to increase the length of time during which sulfur is efficiently removed. Since the useful life of the catalyst-absorbent in the desulfurization cartridge was found to be dependent on such unknown factors as the type and concentration of the sulfur present in the fuel, principles for signaling the end of the useful life of the desulfurization cartridge were investigated. A demonstration test with JP-4 containing 470 ppm of sulfur was run using an existing hydrogen generator modified for operation with a desulfurization cartridge utilizing recycled dilute wet hydrogen. This 200-hour test without loss in performance demonstrates the potential of this method for utilizing JP-4 or CITE in indirect hydrocarbon-air fuel-cell powerplants. Author (TAB)

N67-39486# Naval Ordnance Lab., Corona, Calif.
CHEMOELECTRIC ENERGY CONVERSION FOR NONAQUEOUS RESERVE BATTERIES Quarterly Report, Oct.–Dec. 1966
D. N. Bennion, M. J. Schaer, and W. C. Spindler 15 Aug. 1967 24 p refs
(NOLC-737; AD-658111)

The problem of steady-state sound scattering by an infinite elastic circular cylinder is treated by performing a Sommerfeld-Watson transformation on the normal-mode series. The complex velocities of the ensuing circumferential waves are found by obtaining zeroes of a 3 x 3 determinant in the complex plane, identical to that used by Goodman and Grace in the theory of free vibrations of an elastic cylinder. We find numerically two kinds of zeroes: (Alpha) Franz-type zeroes, similar to (and for aluminum cylinders, almost identical with) those appearing in scattering from rigid cylinders; (Beta) Rayleigh-type zeroes, as found by Goodman and Grace, which for large cylinders tend to the Rayleigh and Stoneley wave velocities, and which enter the cylinder surface at a certain critical angle. These two types correspond to the diffracted and the ordinary surface waves conjectured by Keller and Karal. We also consider the causality relations of sound pulses and show mathematically that they lead to arrival times in accord with the (complex) ray paths of Kellers theory. Finally, the trajectories of the zeroes in the complex plane for variations of ka, and the group velocities of circumferential sound pulses have been obtained. Author (TAB)

N67-39498*# Electro-Optical Systems, Inc., Pasadena, Calif.
THERMIONIC RESEARCH AND DEVELOPMENT PROGRAM Semiannual Progress Report
A. E. Campbell 4 Aug. 1967 66 p refs Prepared for JPL
(Contract NAS7-514)
(NASA-CR-89591; EOS-7118-SA-2) CSCL 10A

The theory of thermionic emission, and ways of improving thermionic converter performance are reviewed, and experiments on vapor-deposited rhenium and electron microscope are reported. Electro emission from four rhenium samples was measured and the average effective work functions are tabulated for temperatures between 1698° and 2336°K. No change in the work function was noted in the sample which underwent electro-etching. The design and operation of the microscope are described, and micrographs before and after secondary recrystallization of a rhenium sampler are presented. It was determined that the preferred orientation exhibited by the vapor-deposited rhenium was along the (002) plane. A typical emission profile obtained by direct measurement of the electron current intercepted by a Faraday cup

located behind the screen aperture is included. An analysis and a computer solution of Poisson's equation for the double diode are discussed. N.E.N.

N67-39644# Electric Storage Battery Co., Madison, Wis. Ray-O-Vac Div.
DEVELOPMENT OF MAGNESIUM FLAT CELL BATTERY Quarterly Report, 1 Feb.–30 Apr. 1967
Philip F. Albert Aug. 1967 50 p
(Contract DA-28-043-AMC-02136(E))
(ECOM-02136-4; Rept.-4; AD-657588)

Delayed capacity performance is tabulated on a series of batteries previously assembled. Graphs are included illustrating the capacity maintenance on the BA-399 and 600 ohms/5 - Continuous drains after various periods of storage at various temperatures. Gas evolution stand test data is presented from immersion of magnesium in electrolyte-manganese dioxide filtrates. An experimentally designed series of batteries was assembled incorporating four variables and three levels of each in an attempt to influence high temperature storage characteristics.
Author (TAB)

N67-39711*# Textron Electronics, Inc., Sylmar, Calif. Heliotek Div.
DEVELOPMENT AND FABRICATION OF RADIATION RESISTANT HIGH EFFICIENCY SOLAR CELLS Final Periodic Report, 24 Aug. 1966–24 Feb. 1967
P. Payne, G. Goodelle, and E. L. Ralph 24 Feb. 1967 71 p refs
(Contract NAS5-10272)
(NASA-CR-89655) CFSTI: $3.00 CSCL 10A

Lithium doped P on N type solar cells of various designs were fabricated and submitted for radiation testing and analysis. Methods were developed for fabricating lithium doped solar cells. The lithium diffusion process was studied and controlled so that the lithium concentration and profile could be varied. It was discovered that the open circuit voltage could be increased with increasing lithium concentration up to a voltage of about 585 mV. Further increases in lithium concentration caused a significant decrease in minority carrier lifetime and, consequently, limited further increases in open circuit voltage. Radiation studies also indicated that there would be an optimum lithium atom concentration for a specific radiation flux level. A special designed phosphorous diffused lithium doped P on N solar cell was developed and is described. This type cell has shown unusually good performance at very high flux levels. Author

N67-39743*# Electro-Optical Systems, Inc., Pasadena, Calif.
PLANETARY SOLAR ARRAY DEVELOPMENT Quarterly Report
R. Wizenick 13 Oct. 1967 65 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952035)
(NASA-CR-89582; EOS-7254-Q-1) CFSTI: $3.00 CSCL 10A

Pressure, density, temperature, gravity, and other parametric value considerations going into a Martian atmospheric model, are listed. The thermal environment, cloud and dust conditions, solar intensity, and radiation environment conditions on Mars are also examined. Sterilization requirements, packaging restraints, deployment, orientation, and structural design considerations for a spacecraft mission to Mars, are discussed. Possible design concepts of solar array instrumentation for recording thermal, radiation, atmospheric composition, and other data during a Martian probe, are described. L.S.

N67-39749*# Thermo Electron Engineering Corp., Waltham, Mass.
SOLAR THERMIONIC GENERATOR DEVELOPMENT Quarterly Report, 9 Jun.–31 Aug. 1967
Sep. 1967 9 p ref
(Contracts NAS7-100; JPL-951283)
(NASA-CR-89554; TE-4055-28-68; QR-7) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Converter fabrication and testing with a new electron-bombardment filament of the U-type is reported for solar thermionic generator development studies. Tests showed very small differences between the performance observed with this type of filament and that of the previous S-type filament. It is recommended that converter testing be conducted with the S filament since it produces a more uniform temperature distribution in the emitter. Another converter was fabricated with a palladium collector. It was outgassed for 65 hours at an observed emitter temperature of 1675°C. Cesium distillation was conducted for 5 hours at 200°C. S.P.

N67-39752# Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.
ELECTRICAL COMPONENT TECHNOLOGY FOR 0.25 TO 10.0 MEGAWATT SPACE POWER SYSTEMS Quarterly Technical Progress Report, Dec. 1, 1966–Feb. 28, 1967
A. E. King, ed. Aug. 1967 233 p refs
(Contract AT(04-3)-679)
(SAN-679-2; QTPR-2) CFSTI: HC $3.00/MF $0.65

Progress on parametric studies to determine minimum system weight as a function of electrical component rating, voltage, frequency and speed are presented on ac generators, ac motors, power conditioning and power distribution equipment for 0.25 to 10.0 megawatt space nuclear electric power plants utilizing the Rankine conversion cycle. Final parametric data are presented on frequency changers in the 5 to 500 kva range as well as on contactors in the 0.05 to 10.0 mva range. Electrical power uses and missions analyses are presented to illustrate electrical load breakdown on probable missions requiring 0.25 to 10 megawatts of power. Progress on experiments to verify analytical techniques for inductor generator designs typical of high-power, high-speed, high-frequency, high-temperature applications is presented. Analysis of tests to verify magnetic forces between an eccentric rotor and stator of an inductor alternator is included. Author (NSA)

N67-39754# Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.
ELECTRICAL COMPONENT TECHNOLOGY FOR 0.25 TO 10.0 MEGAWATT SPACE POWER SYSTEMS, DESIGN STUDY Quarterly Technical Progress Report, Sep. 1–Nov. 30, 1966
A. E. King, ed. Aug. 1967 154 p refs
(Contract AT(04-3)-679)
(SAN-679-1; QTPR-1) CFSTI: HC $3.00/MF $0.65

Background technology, design philosophies, and parametric screening study plans are presented on ac generators, ac motors, power conditioning and power distribution equipment for 0.25 to 10.0 megawatt space nuclear electric power plants utilizing the Rankine conversion cycle. The power conditioning and distribution equipment includes transformers, rectifiers, frequency changers, contactors and transmission lines. Radiation degradation of electrical components is considered. Progress on experiments to verify analytical techniques for inductor generator designs typical of high-power, high-speed, high-frequency, high-temperature applications is included. Author (NSA)

N67-39799* Duke Univ., Durham, N. C. Dept. of Electrical Engineering.
A STATIC DC–DC REGULATED CONVERTER USING A TWO-CORE OUTPUT TRANSFORMER
William August Sander, III (M.S. Thesis) 31 Aug. 1967 109 p refs
(Grant NsG-152-61)
(NASA-CR-89580) CSCL 10A

A novel design solution to the problem of regulating a dc to dc current feedback inverter by the use of a two-core output transformer is described. The operation and design of the current feedback inverter, which provides a symmetric alternating square wave voltage, are discussed. Once an alternating voltage is obtained which can be used to drive the transformer, the theory of the transformer is discussed. Beginning with the equations for the net mmf on the two cores, an expression is derived relating the ratio of output power and control power to the ratio of the flux rates of change in the two cores. An analysis is made to determine the range of flux rate of change required in the core associated with the control circuit. Results show that a compromise has to be made between the ratio of output power and control power and the regulation range. The analysis and design of the feedback and control circuits are discussed. An analysis of experimental data shows that the converter has favorable regulation characteristics, low output-voltage ripple, and a maximum efficiency of 75%. R.N.A.

N67-39880*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SMALL-SAMPLE EVALUATION OF SQUIB TIME-CURRENT FIRING CHARACTERISTICS
A. G. Benedict 15 Oct. 1967 18 p refs
(Contract NAS7-100)
(NASA-CR-89598; JPL-TR-32-1164) CFSTI: HC $3.00/MF $0.65 CSCL 19A

A universal firing curve template can be used as a guide for testing hot-wire squibs, provided the squibs exhibit only one significant thermal time constant. By combining the template with tests by variables, as few as six squibs can provide useful information relating to percentiles in either the all-fire or the no-fire regions. Author

N67-39903# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Aero Propulsion Lab.
AN ANALYSIS OF LOW ORBITAL DRAG CONSTRAINTS OF ORBIT- AND SUN-ORIENTED, SOLAR-CELL ARRAYS
Paul W. Launderback 1967 31 p refs Presented at the 1967 Intersociety Energy-Conversion Eng. Conf., Miami, 13–17 Aug. 1967
(AFAPL-CONF-68-2; AD-658453)

A comparison of orbit- and sun-oriented solar-cell-array concepts to produce space power in low-earth orbits has been conducted. Results obtained show that aerodynamic drag penalties as large as 9100 pounds/kilowatt for a one-year mission may be encountered. The contribution of a drag makeup system to the total system specific weight for an orbit- or sun-oriented array is negligible above 250 and 375 nautical miles respectively. Below 185 nautical miles and for a mission duration of one year, the orbit-oriented array concept is more desirable from a weight standpoint. The study has included only the effects of aerodynamic drag. The drag makeup system consists of propulsive devices and storage tanks. For each concept the total system includes drag makeup, batteries, and solar-cell array. Author (TAB)

N67-39942# Tactical Air Command, Langley AFB, Va.
ELECTRICAL POWER DISTRIBUTION AT 400Hz TO TACTICAL GROUND UNITS
O. E. Hagstrom and Victor M. Harkavy Sep. 1967 32 p refs
(TAC-OA-TM-131; AD-658444)

A new look at central power plant generation for mobile 400 Hz power utilization is covered in this memorandum. If the distances are not excessive (above 3,000-4,000 ft), the transmission line losses are acceptable and the other advantages of central power generation may be utilized. Author (TAB)

N67-39960*# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.
SOLAR-POWERED ELECTRIC PROPULSION SPACECRAFT Bimonthly Report
Robert H. Stiyers Jul. 1965 225 p Prepared for JPL
(Contract JPL-951144)
(NASA-CR-89653; Rept.-2) CFSTI: $3.00 CSCL 10B

The main objective of the mission is to deliver a scientific payload and a reliable telecommunications system into an orbit around Mars. The purpose of this study is to consider a solar electric powered final stage spacecraft for this mission and to compare this with an all chemical system. Mission profiles and mission analyses were performed which established the following design points for an electrically propelled spacecraft launched by a Saturn IB/Centaur: Hg bombardment engine, 400 sec specific impulse, 48 kW power requirement, 1600 lbs propellant weight, and thrust vector through 50°. Missions for several launch years were studied under conditions of zero hyperbolic excess, 150 to 500 days flight time, 3000 to 6000 sec specific impulse, and optimum thrust orientation. Propulsion system studies were performed which consisted of: (1) power level effect on design and operating characteristics; (2) a reliability analysis of optimum thrustor module size for a high power system and overall effects on design; (3) subsystem design layout for a 48 kW ion propulsion system; (4) power matching; and (5) a scaling study. Spacecraft system design studies covered the scientific payload, retro propulsion, thermal control, attitude control, telecommunication, structural and dynamics analyses, and system analyses. K.W.

N67-40064*# Harshaw Chemical Co., Cleveland, Ohio.
DEVELOPMENT OF CADMIUM SULFIDE PHOTOVOLTAIC FILM CELLS Final Report
J. C. Schaefer, J. Evans, and T. A. Griffin Oct. 1967 77 p refs
(Contract NAS3-8515)
(NASA-CR-72296) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Control of the carrier concentration in the CdS film has provided improved yields. Voltages up to 0.55 volts and cell conversion efficiencies up to 7.1% were reported with typical cell efficiencies ranging from 4.0 to 5.4%. The correlation between cell open circuit voltage and carrier concentration of the film has been demonstrated. Author

N67-40069*# National Aeronautics and Space Administration, Washington, D. C.
ELECTRIC POWER FOR THE SCIENTIFIC EXPLORATION OF THE SOLAR SYSTEM
Arvin H. Smith [1967] 32 p refs
(NASA-CR-89744) CFSTI: HC $3.00 CSCL 10B

Electric power systems considered to be applicable to the unmanned scientific exploration of the solar system are examined. Typical solar cell-battery systems used on recent missions such as Ranger, OGO, and Mariner are described. Representative load requirements and the need for power management and conditioning are reviewed. Endurance, reliability, and weight are seen as the more important factors in power source selection. As a consequence, solar cells and batteries can be expected to play a dominant role in the range of interplanetary missions from the planets Venus to Mars. For missions to Jupiter and beyond, isotope thermoelectric (or thermionic) generators are expected to find application. Solar thermionic sources are seen to have potential for missions to Mercury and close to the Sun. Author

N67-40088*# David Sarnoff Research Center, Princeton, N. J. Astro-Electronics Applied Research Lab.
REVIEW AND EVALUATION OF PAST SOLAR CELL DEVELOPMENT EFFORTS

P. A. Crossley, G. T. Noel, and M. Wolf Jun. 1967 87 p refs
(Contract NASw-1427)
(NASA-CR-89662) CFSTI: HC $3.00/MF $0.65 CSCL 10A

A bibliography is presented for scientific papers related to the photovoltaic effect, and a historical review of scientific investigations of this effect during the years 1839–1940 is given. Topics covered include the Becquerel effect, the barrier photovoltaic effect, and the Dember effect. Because of its historical importance, major emphasis has been planced on the barrier photovoltaic effect as seen in copper-cuprous oxide photocells. All experimental investigations as reported in the literature have been covered, and the development of the modern theory of the photovoltaic effect is described. Author

N67-40098*# TRW Systems Group, Redondo Beach, Calif.
POWER SYSTEM CONFIGURATION STUDY AND RELIABILITY ANALYSIS. SPACECRAFT POWER SYSTEM CONFIGURATION REFERENCE MANUAL
W. G. Binckley 18 Sep. 1967 242 p
(Contract JPL-951574)
(NASA-CR-89596; TRW-97171-6002-R000) CFSTI: HC $3.00/MF $0.65 CSCL 10B

A method of performing preliminary power system tradeoffs to select optimum configurations on the basis of minimum weight and maximum reliability is presented. Model sets of power system requirements for interplanetary missions to Mercury, Venus, Mars and Jupiter and representative spacecraft configurations are provided. Candidate power system configurations and design approaches for each unit, and preferred methods of implementing unit redundancy and the effects of redundancy on unit weight and efficiency are described. A computer program to perform individual system reliability weight optimization and to select minimum weight system configurations as a function of reliability is described. Results of applying this optimization method to seven model spacecraft/mission applications are presented. Important system design considerations in the implementation of preferred system configurations are discussed and include electromagnetic compatibility, thermal interfaces, and command and telemetry provisions. Author

N67-40131* Monsanto Research Corp., Dayton, Ohio. Dayton Lab.
SILVER–ZINC BATTERY SEPARATOR MATERIAL DEVELOPMENT Quarterly Progress Report, 1 Jul.–30 Sep. 1967
I. O. Salyer, E. V. Kirkland, G. L. Ball, III, P. N. Wilken, and L. E. Erbaugh 10 Oct. 1967 25 p Prepared for JPL
(Contracts NAS7-100; JPL-951966)
(NASA-CR-89639; QPR-1) CSCL 10C

With a limited quantity of ethylene/acrylic acid copolymer (cross-linked), some electrical measurements of resistance of the wet sheet indicate the potential value of these copolymers as separators for silver–zinc batteries. A few small samples of ethylene/methyl acrylate copolymers were made in a small rocker bomb. A one liter high pressure stirred reactor was set up to synthesize larger quantities of copolymer. Author

N67-40137*# Thompson (John I.) and Co., Inc., Washington, D. C.
FUEL CELLS—A REVIEW OF GOVERNMENT-SPONSORED RESEARCH, 1950–1964
L. G. Austin (North Carolina State Univ.) 1967 451 p refs
(Contract NASw-1039)
(NASA-SP-120) CFSTI: HC $3.00/MF $0.65 CSCL 10A

A comprehensive review of fuel cell research and technology is presented. The review covers the principles, types, and uses of fuel cells; fuel cell electrodes, electrolytes, and matrices; low temperatue, medium temperatue, and high temperatue fuel cell and stack construction; sodium amalgam–oxygen cell and stack construction; fuel cell systems and control; electrolytically regenerative hydrox fuel cells; thermally regenerative fule cells; thermogalvanic cells; photochemically regenerative and redox cells; hybrid fuel cells; biochemical fuel cells; direct hydrocarbon fuel cells; miscellaneous fuels and oxidants; kinetics of hydrox fuel cell reactions; and theories of porous electrodes. R.N.A.

N67-40211# Naval Research Lab., Washington, D. C.
REFRACTOMETRIC SENSING OF H_2SO_4 SPECIFIC GRAVITY IN LEAD–ACID CELL OPERATION
Jeanne Burbank 5 Jul. 1967 16 p refs
(NRL-6562; AD-658747)

A simple inexpensive dipping refractometer for continuous automatic monitoring of the refractive index of fluids was used to record the changes in electrolyte specific gravity during cycling of a lead-acid cell. It introduces no contamination, is durable, and minimizes test sampling and personal attendance. It may be adapted for automatic control systems and can be operated as a level indicator. Author (TAB)

N67-40347* Fairchild Hiller Corp., Germantown, Md. Space and Electronics Systems Div.
FABRICATION FEASIBILITY STUDY OF A 30 WATT-POUND ROLL-UP SOLAR ARRAY Quarterly Report, 27 Jun.–30 Sep. 1967
W. G. King 15 Oct. 1967 18 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951969)
(NASA-CR-89752; Doc.-652-00101-QR; QR-1) CSCL 10A

This document presents the results of the first quarter of a one-year study to evaluate the feasibility of fabricating a 30 watt/pound or greater roll-up solar array. This study includes the parametric investigation of factors effecting the power/weight ratio and concentrates attention on the deployment/retraction mechanisms and supporting structures rather than on the electrical aspects of the design. Preliminary parametric study results are presented as are also conceptual designs of components for two array supporting structure configurations. Author

N67-40403# Brookhaven National Lab., Upton, N. Y.
SOME TECHNICAL AND ECONOMIC ASPECTS OF RADIOCATALYSIS IN APPLICATION TO FUEL CELLS
J. F. Henry and E. Gevenois May 1967 33 p Transl. into ENGLISH from the French Report
(BNL-Tr-142) CFSTI: HC $3.00/MF $0.65

It was found that the cost of energy produced by an activated cell is higher than the cost of energy produced by an unactivated cell. When the terminal voltage of the cells is fixed, an activated cell may be more economical than an unactivated cell provided the fixed voltage is above a certain limit which is a function of the characteristic cell parameters. This conclusion holds in particular for cells containing ^{14}C and ^{60}Co. When the current density is fixed, it appears that an activated cell is more economical than an unactivated cell provided the current density is above a limit determined by the parameter characterizing the cells. Cell activation permits reduction of volume and weight. It is possible in principle to build cells that are more compact, lighter and more economical by using radioelements incorporated in the cell. Results show that in some cases, and for the cells considered, introduction of radioelements is technically and economically advantageous. For military and space applications substantial weight reduction and compactness gains due to activation are especially desirable. This applies particularly to ^{14}C or ^{63}Ni activation, which does not present safety problems. Author (NSA)

N67-40430*# General Electric Co., Philadelphia, Pa. Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. Missile and Space Div.
FEASIBILITY STUDY—30 WATT PER POUND ROLL-UP SOLAR ARRAY Quarterly Technical Report, 1 Jul.–30 Sep. 1967
K. L. Hanson, F. A. Balke, W. S. Busch, R. S. Kyle, P. J. Demartion et al 15 Oct. 1967 86 p ref Prepared for JPL
(Contracts NAS7-100; JPL-951-970)
(NASA-CR-89795; Rept.-67SD4403; QTR-1) CFSTI: $3.00 CSCL 10A

Results of the activities performed during the first quarter of the program to establish feasibility of a 30 watt per pound roll-up Solar array are reported. These include the results of the configuration arrangements study, the results to date of the deployment rod tradeoff study, the summary of the parameters for each of the two candidate deployment configurations with each of the candidate rods, and the results to date of the initial detail design of the solar panel components. Author

N67-40475* Electro-Optical Systems, Inc., Pasadena, Calif.
HYDROGEN–OXYGEN ELECTROLYTIC REGENERATIVE FUEL CELLS, 1 MAY 1967–1 JUNE 1967
Robert F. Astrin and Martin G. Klein 10 Jun. 1967 23 p
(Contract NAS3-2781)
(NASA-CR-89753; EOS-4110-ML-36) CSCL 10A

During this period, primary emphasis was placed on the testing of single cells with matrix structures of potassium titanate and Teflon. Reference cells were assembled and tested. A six-cell unit was tested. Fabrication has begun on the 28-volt 500-watt flight prototype fuel cell assembly. Author

N67-40508* Electro-Optical Systems, Inc., Pasadena, Calif.
HYDROGEN–OXYGEN ELECTROLYTIC REGENERATIVE FUEL CELLS, 1 JUNE 1967–JULY 1967
Robert F. Astrin and Martin G. Klein 10 Jul. 1967 25 p
(Contract NAS3-2781)
(NASA-CR-89754; EOS-4100-ML-37) CSCL 10A

During this period, primary emphasis was placed on the testing of single cells with matrix structures of potassium titanate, Teflon, and asbestos. Reference cells were assembled and tested. Fabrication is progressing on the 28-volt 500-watt flight prototype fuel cell assembly. Author

N67-40535*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CENTAUR SOLID STATE INVERTER FAILURE DURING SIMULATED FLIGHT IN AN ENVIRONMENTAL SPACE CHAMBER
Ralph F. Schmiedlin and B. J. Dastoli Washington, NASA, 1967 23 p refs
(NASA-TM-X-52336) CFSTI: HC$3.00/MF$0.65 CSCL 10B

A solid state inverter failed during flight simulation testing of a Centaur vehicle in an environmental space chamber. Inspection showed the presence of small metal particles and burrs on the inverter overload sensing shunt. The failure, an electrical short circuit, was analyzed and found to be a result of a metal particle cutting through the insulation between the shunt and an aluminum heat sink. While this is a single instance of failure of a key component of a space launch vehicle, we believe that it is a typical example indicating the need for greater attention to detail in the design of components, the preparation of the specifications, the manufacturing process, and the inspection of aerospace components. Also, this failure shows the importance of environmental testing under cyclic conditions in uncovering deficient or marginal vehicle components. Such tests should be done extensively at system or subsystem level before testing at vehicle level. In general, such is the case for Centaur vehicle systems. Author

N67-40545* Marquardt Corp., Van Nuys, Calif.
TEST PLAN FOR THE NASA GH2–GO2 SPACE POWER UNIT NO. 2A-3
[1967] 19 p
(Contract NAS9-857)
(NASA-CR-89587) CSCL 10B

The test engine is a single cylinder, liquid cooled, reciprocating machine which operates on gaseous hydrogen and oxygen propellants injected directly into the cylinder. Engine propellant injection and ignition systems are described. Test objectives are specified and test facilities and procedures are summarized. Existing hypergolic space power unit test facilities will be used with additions for tankage, control, and measurement of the flow rates of the hydrogen and oxygen propellants. Tables show engine component instrumentation, test schedules, injector valve calibration, and ignition and engine test specifications. Schematics are also given for injector valve calibration, and propellant, cooling, and drive systems. E.C.

N67-40593*# Borden Chemical Co., Philadelphia, Pa. Central Research Lab.
IMPROVED SEPARATORS FOR SILVER OXIDE–ZINC AND SILVER OXIDE–CADMIUM CELLS FOR SPACECRAFT APPLICATION Final Report
Helmuth L. Pfluger and Howard E. Hoyt Jul. 1967 106 p refs
(Contract NAS5-9107)
(NASA-CR-89615) CFSTI: HC$3.00/MF$0.65 CSCL 10C

Screening tests and investigations of materials and techniques to improve separators are reported. Materials judged worthy of further evaluation singly are listed, along with those in combinations of two, one to stop silver ion by reducing it to metallic silver and one to permit small amounts of silver ion to diffuse but being resistant to zinc. A new wrapping technique superimposes thin sheets of two separator types, followed by U-wrapping with the double layer as though it were a single sheet. It is pointed out that electrolytic conductivity of membranes comprising methyl cellulose can be increased as much as one hundred-fold by preswelling, and ways of exploiting preswelling are discussed. Screening tests indicate that methacrylic ester–acrylic acid copolymers and polyvinyl pyridine–polyacid co-acervates are oxidation resistant and within a useful electrolytic resistance range. N.E.N.

04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

N67-39409# Army Edgewood Arsenal, Md. Medical Research Lab.
THE SUBHUMAN PRIMATE: A GUIDE FOR THE VETERINARIAN
Robert A. Whitney, Jr., Donald J. Johnson, and William C. Cole Jun. 1967 107 p refs
(EASP-100-26; AD-657570)

The regulations and standards of the Laboratory Animal Welfare Act, PL 89-544, require programs of disease control and prevention, euthanasia, and adequate veterinary care maintained under the supervision of a Doctor of Veterinary Medicine in research facilities that use subhuman primates, as well as dogs and cats. This guide is an attempt to provide the veterinarian with a broad familiarity with procurement, housing and care, techniques, nutrition, infectious diseases, and classification of subhuman primates and to provide references for more detailed requirements in specific areas. Author (TAB)

N67-39420# Nagasaki Univ. (Japan). School of Medicine.
BIO-INFORMATION PROCESSINGS OF THE ELECTROENCEPHALOGRAPHIC MASSPOTENTIALS IN ANIMAL AND MAN Final Report, 5 May 1966–4 May 1967
Kensuke Sato Jul. 1967 89 p refs
(Contract DA-92-557-FEC-39566)
(J-267-2; AD-658170)

Bio-information processings of the brain masspotentials of man, monkey, cat and rabbit, which were recorded on magnetic tapes, were carried out through General Purpose Digital Computers. Evidences were found to suggest that man and animal brains operate their bio-information processing through normal Gaussian stochastic processes, at least for the first approximation. Late responses in the visual evoked potential of cerebral cortex of man, monkey, cat and rabbit were also manifested as related to stages of background EEG activities shown in their autocorrelograms. It was found that peak latencies of later responses of cerebral palsy children were reduced compared with those of normal children, and those of later oscillatory potentials of rabbit also abbreviated progressively with lowering background EEG activities, though those of initial oscillatory potentials were elongated more and more. The former evidences may suggest impaired negative feed back action, such as recurrent inhibition. Alpha, beta, theta and delta waves in EEG were simulated by repetitive summation of an evoked potential elicited by a single flash stimulus with the same repetitive frequencies as each of the above EEG waves. This finding suggests that the EEG generating mechanism would be a masspotential due to changes in membrane potentials of cerebral neurone aggregates elicited by enumerable afferent trains of impulses.
Author (TAB)

N67-39484# Weizmann Inst. of Science, Rehovoth (Israel).
WATER INSOLUBLE DERIVATIVES OF PROTEINS WITH BIOLOGICAL ACTIVITY Technical Report, 1 Jul. 1966–30 Jun. 1967
Ephraim Katchalski 30 Jun. 1967 20 p refs
(Grant AF-EOAR-67-14)
(AFOSR-67-2025; AD-657797)

A number of derivatives of papain and chymotypsin were prepared in which the active enzyme was covalently bound to a high-molecular weight carrier (e.g., poly-L-ornithyl papain, poly-L-glutamyl chymotrypsin). A kinetic study was made of these compounds, with particular attention given to pH activity profiles. Papain-collodion membranes were also prepared and were examined with respect to the effect of local gradients of enzyme and substrate on their kinetic activity.
TAB

N67-39514# Defence Research Board, Ottawa (Ontario).
SPECIES–CHARACTERISTICS OF THERMOGENESIS FOLLOWING HYPOTHERMIA IN RODENTS
L. A. Isaakian, D. A. Rozhaiya, and L. S. Maslennikova May 1967 9 p refs Transl. into ENGLISH from Zh. Evolyutsionnoi Biokhim i Fiziol. (Moscow), v. 1, no. 5, 1965 p 419–424
(DRB-T-471-4)

The thermogenetic capacities of certain rodent species during the process of rewarming after hypothermia induced in rats, mice, and hamsters are examined. The dynamics of restoration of heat production and body temperature at the 23°C environmental temperature immediately after cooling to a body temperature of 16–20°C is illustrated. It is shown that the highest level of oxygen consumption per kg of weight appears in the mice, and the lowest in the rats. Species characteristics are demonstrated in this case and in the case of oxygen consumption in rats and hamsters of the same weight, both in the hypothermal state and in the normal thermal state. In the normal state the gaseous metabolism of hamsters was at a 20% higher level than in the rats; whereas the maximum level of metabolism in the hamsters during hypothermia was 42% higher than in the rats. In the species studied the spontaneous reanimation capacities differed, though they were determined by the temperature of the environment in which the emergence from hypothermia took place, and by the depth of hypothermia. The characteristic species-differences exhibited in recovery from the hypothermal state were undoubtedly related to species-differences of the thermogenetic mechanisms.
S.P.

N67-39518# RAND Corp., Santa Monica, Calif.
LIFE IN THE UNIVERSE
S. H. Dole Sep. 1967 21 p Presented at Hawthorne School, Beverly Hills, Calif., 28 Jul. 1967
(P-3669; AD-658009)

If life will appear whenever the conditions are tolerable, as stated by many modern scientists, and if there are numerous planets in the right mass range orbiting at the proper distance around suitable stars, then life must be quite common. Assuming here that the word life, wherever it appears, implies life based on water and on carbon compounds, that is, life as-we-know-it and as found on the surface of the earth. There are some very good arguments in support of this. Another argument depends on the very unusual properties of water and of the compounds of carbon. Water is an amazing material--there is no other compound that comes close to it in many of its properties. Similarly, no other element but carbon has the property of being able to form such an enormous variety of complicated long-chain compounds--as are demanded by life processes. Something like half-a-million compounds of carbon have been identified--which is perhaps 50 times as many as all the chemical compounds that do not contain carbon.
TAB

N67-39546# School of Aerospace Medicine, Brooks AFB, Tex.
DETERMINATIONS OF ACHROMATIC VISUAL THRESHOLDS IN MAN FOLLOWING EXPOSURE TO ULTRASHORT, ULTRAVIOLET AND ROENTGEN WAVES [OB IZMERENII PEROGOV AKHROMATICHESKOGO ZRENIYA CHELOVEKA PRI DEISTVII ULTRAKOROTKIKH, ULTRAFIOLETOVYKH I RENTGENOVYKH VOLN]
K. Kh. Kekcheev [1967] 7 p Transl. into ENGLISH from the publ. "Problemy Fiziologicheskoi Optiki" Moscow, Acad. Nauk SSSR, v. 1, 1941 p 77
(SAM-TT-R-880-0367; TT-60-13098; AD-653949) CFSTI: HC $3.00/MF $0.65

A series of experiments was carried out using short electromagnetic waves, exposing wrists to small amounts of X-rays (30–100 *r*). It is known that erythema usually appears on the sixth day after a dose of 600 r. However, changes in the visual threshold were noted one day after exposure to doses that were 6 to 20 times smaller (100–30 r) than the dose causing erythema. These changes were observed for several days. During the 'blind tests' all conditions were the same with one exception: a thick lead shield was placed between the patient and the source of radiation. In this manner, X-ray wave lengths from 1×10^{-7} to 1×10^{-8} cm (millimicrons and tenths of millimicrons) have, in either case, an effect on the autonomic nervous system. The experiments were continued using long electromagnetic waves rather than those of the visible spectrum. The experiment consisted of 47 tests on seven subjects. Control experiments (heat applied on abdomen and back) showed no changes. Ultrashort waves showed a marked effect on the visual threshold within a few hours. Separate tests were carried out also with short waves (length of waves approximately 50 meters) with equally valuable results. The experiments indicate that the autonomic nervous system of man is effected by a very large spread of electromagnetic wave lengths.
TAB

N67-39572# Saint Mary's Hospital, San Francisco, Calif. Dept. of Medical Education.
PHYSICAL FITNESS AND HUMAN TOLERANCE TO ACUTE EXPOSURE TO LIFE AT HIGH ALTITUDE. EXPERIMENTAL DESIGN AND DATA PROCESSING METHODOLOGY FOR CLINICAL PHYSIOLOGICAL OBSERVATIONS Progress Report
Cutting B. Favour 1967 35 p refs
(Contract DA-49-193-MX-3059)
(PR-1967-1; AD-658185)

A description is given of the methods by which measurements of various physiologic changes during exposure to altitude were collected. The type of log books which were kept are described in detail. The data processing system had five stages: (1) Chronological logging of raw data in separate log books; (2) preparation of edited input data sheets and data cards; (3) Computer output and human editing of data output cards; (4) Computer output and human editing of summary output cards; (5) computer output and final human interpretation of P and F values for significance of the results obtained. TAB

N67-39631# Washington Univ., Seattle.
ON THE "JUST NOTICEABLE DEPARTURE" OF DATA FROM THEORY
John van Laer 15 Jul. 1967 13 p refs
(Contract DA-49-193-MD-2713)
(PRP-36A; AD-657934)

A lower bound on the noncentrality parameter of the chi-square test of goodness of fit is derived. The bound is a function of the average of absolute discrepancies between theoretical and true probabilities. This bound provides a method that estimates the correspondence between theory and data, and that nullifies, in part, Grants strictures against traditional goodness-of-fit tests. The method also serves as a guide to planning an empirical evaluation of a quantitative theoretical model, when a chi-square test of goodness of fit is contemplated. Author (TAB)

N67-39647* California Univ., Los Angeles. School of Medicine.
KIDNEY PARENCHYMAL OXYGEN TENSION DETERMINED BY RENAL LYMPH CANNULATION
A. T. K. Cockett, A. P. Roberts, and R. S. Moore [1966] 11 p refs
(Grants NsG-237-62; PHS HE-09834-02)
(NASA-CR-89647) CSCL 06C

The results of kidney oxygen tension measurements by renal lymph cannulation in dogs showed that renal capsular lymph has a higher oxygen tension than hilar lymph. These findings support the present concept of plasma skimming with separation of intrarenal blood flow. The kidney cells are dependent on an oxygen gradient involving partial pressures of dissolved gases diffusing between plasma and the interstitial compartment. Intracellular oxidative metabolism is another factor to be considered in oxygen diffusion into lymph. Oxygen tension in the cisterna chyli lymph system was not significantly lower than renal hilar lymph. Thoracic duct lymph oxygen tension was significantly lower than the cisterna chyli fluid. R.N.A.

N67-39650# Michigan State Univ., East Lansing. Dept. of Biophysics.
THE SEMICONDUCTIVE PROPERTIES OF LIPIDS AND THEIR RELATION TO THE ELECTRICAL CONDUCTIVITY OF LIPID BILAYERS
Gordon Lee Jendrasiak Aug. 1967 132 p refs
(Contract Nonr-2587(06))
(TR-1; AD-657954)

A study was made showing that lipid films in the dry state behave as electrical semiconductors with high activation energies. For phospholipids, these activation energies range from 4.8 to 6.3 e.v. Upon hydration, the activation energies decrease whereas the conductivities increase. An effect parallel to that of water is found with exposure of lipids to iodine vapor; here the activation energies range from 2.7 to 3.2 e.v. With the adsorption of either water or iodine, the dielectric constant, frequency dispersion and dissipation factor of the lipids increased over the dry state values. Lipid bilayers were found to exhibit an increase of 1000 to 100000 in their electrical conductivity with exposure of the bilayer to iodine solution. Spectroscopic evidence was obtained indicating that lipids form charge-transfer complexes with iodine. This charge transfer evidence is taken as suggestive of a possible electronic conduction mechanism, not only in the lipid films, but also in the lipid bilayers. TAB

N67-39676# Naval School of Aviation Medicine, Pensacola, Fla.
RELATIONS BETWEEN VESTIBULAR NYSTAGMUS AND VISUAL PERFORMANCE
Fred E. Guedry, Jr. 24 May 1967 28 p refs Prepared jointly with Army Aeromed. Res. Unit
(NAMI-1008; AD-657847)

Relationships between vestibular nystagmus and visual acuity were measured during application of different magnitude vestibular stimuli which interfered with voluntary efforts to see visual detail in controlled illumination. Significant relations were found among vestibular stimulus magnitude, nystagmus, and visual acuity. During illumination, nystagmus growth and decay curves depart markedly from curves found in darkness and from theoretical expectations. Steps in nystagmus slow phase velocity appear to be related to steplike shifts in visual acuity while steps in nystagmus amplitude seem to signify the point of surrender of voluntary efforts to maintain clear vision. Step-changes in nystagmus may explain the physiological third stage of spin reported in jet aircraft. Individual differences in Dynamic Visual Acuity-Vestibular are discussed in relation to Dynamic Visual Acuity and also in relation to flight safety. Author (TAB)

N67-39680# Naval Air Development Center, Johnsville, Pa. Aerospace Medical Research Dept.
LUNG CHANGES RESULTING FROM PROLONGED EXPOSURE TO 100% OXYGEN AT 550 MM HG
George H. Kydd 17 May 1967 31 p refs
(NADC-MR-6710; AD-658720)

Rats exposed to 100% oxygen at 500 mm Hg for 30 days survive and show no respiratory or other difficulty during the exposure. Histological examination of the lung tissue indicates that the blood vessels of the lung have undergone a change in structure during the exposure. The results suggest that the media is eroded as evidenced by thin vessel walls and by streaming of the media into the adventitia. There is also evidence of hypertrophy and/or hyperplasia in the vessel walls. Author (TAB)

N67-39688# Saint Mary's Hospital, San Francisco, Calif.
PHYSICAL FITNESS AND HUMAN TOLERANCE TO ACUTE EXPOSURE TO LIFE AT HIGH ALTITUDE. EFFECT ON HEMATOCRIT AND HEMOGLOBIN VALUES OF VARIATIONS IN THE STATE OF PHYSICAL ACTIVITY, PHYSICAL CONDITION AND ALTITUDE
Cutting B. Favour, John A. Faulkner (Mich. Univ., Ann Arbor), and James Kollas (Pa. State Univ.) Mar. 1967 20 p refs
(Contract DA-49-193-MX-3059)
(PR-1967-4; AD-658169)

Attention was focused on three variables: (1) The role of exercise in raising the hematocrit; (2) the role of physical fitness

in preserving a degree of homeostasis close to an hematocrit level of 40 which is the viscosity and cell concentration for optimal oxygen flow to the tissue; and (3) the role of changing altitudes as an independent variable which change is associated with a rise in hemstocrit and hemoglobin both at rest and during exercise and more so in the sedentary than in the fit subject. The data suggest that the peripheral venous blood hematocrit and hemoglobin levels are lower in athletes than they are in sedentary or fit subjects. Exposing athletes to high altitude apparently does not raise these lower hematocrit and hemoglobin levels as much as this exposure does in healthy normal subjects. This phenomenon can be interpreted to be evidence for a physiological cross-adaptation between high degrees of physical fitness and speed of acclimatization to high altitude. Author (TAB)

N67-39702# Naval Air Development Center, Johnsville, Pa. Aerospace Medical Research Dept.

THE EFFECT OF WATER IMMERSION AND BODY POSITION UPON PERCEPTION OF THE GRAVITATIONAL VERTICAL

John G. Nelson 18 Jul. 1967 27 p refs
(NADC-MR-6709; Rept.-10; AD-658507)

The purpose of this study was to measure the accuracy, particularly the sensitivity or short-term repeatability, with which humans can use their vestibular sense to preceive the gravitational vertical, and how this ability varies with body (head) position. Equipment and procedures to reduce or eliminate nonvestibular cues were selected through iterative process of design, development, test, and evaluation. Ss were restrained upon an underwater 2-axis tilt table, and required to position themselves, via signals to Es, in one of 6 cardinal positions of the body (head) with respect to gravity. Seven Ss, in 3 immersions each, made 3 judgements per immersion at each of the 6 positions. The group responses showed some large and significant constant error, most notably a pitch-forward bias shared (unequally) by all of the medial-plane positions, exceeding 30 degrees in the nominal head-down position. A Probable Error, (PE), uninflated by constant errors, was computed for each of the 2 orthogonal directions of deviation for each of the 6 positions. The results supported the classical concept of reduced sensitivity in the head-down as compared with the head-up positions. However, PE ranged from 15 degrees to 40 degrees, indicating only a marginally useful sensitivity in any position. In addition, sensitivity at any one position was not necessarily symmetrical as to direction of deviation, and some sensitivities at intermediate values of tilt overlapped head-up or head-down sensitivities. Author (TAB)

N67-39776*# Naval School of Aviation Medicine, Pensacola, Fla.

VESTIBULAR REACTIONS IN CAT AND MAN DURING AND AFTER ANGULAR ACCELERATIONS. II: RESPONSES TO LATERAL CANAL STIMULI OF VARIOUS ACCELERATIONS

Fred E. Guedry, Jr., and William E. Collins Jun. 1967 15 p refs
(NASA Order R-93)
(NASA-CR-89670; NAMI-1012) CFSTI: HC $3.00/MF $0.65 CSCL 06P

A direct relationship between duration of acceleration and decline of response during acceleration, rate of decline of response after acceleration, and magnitude of secondary reaction is regarded as an indication of a central process which limits a prolonged vestibular primary reaction. The process is manifested by its influence on relatively basic reflex reactions (nystagmus) in the cat, and is more prominently manifested in man by its influence on sensory perception. Author

N67-39777*# Naval School of Aviation Medicine, Pensacola, Fla.

VESTIBULAR REACTIONS IN CAT AND MAN DURING AND AFTER ANGULAR ACCELERATION. 1: RESPONSES FROM THE LATERAL AND THE VERTICAL CANALS TO TWO STIMULUS DURATIONS

William E. Collins and Fred E. Guedry, Jr. Jun. 1967 19 p refs
(NASA Order R-93)
(NASA-CR-89669; NAMI-1011) CFSTI: HC $3.00/MF $0.65 CSCL 06P

Ocular nystagmus was recorded in darkness from cat and man during 4-deg/sec^2 accelerations about an Earth-vertical axis. Lateral-canal stimulation yielded greater primary and secondary nystagmus than did vertical-canal stimulation. In cat, both lateral- and vertical-canal responses to a 36-second stimuli peaked after 15–21 seconds of angular acceleration, and this was followed by a steady decline. Declines during acceleration were not apparent in nystagmus of man. There was a more consistent secondary nystagmus in cat than in man. In cat, primary after-nystagmus was greater following an 8.4-second stimulus than following a 36-second stimulus. In man, a like difference occurred in the sensation but was not present in nystagmus. In this regard, nystagmus from cat resembled the subjective reactions of men more than they did the nystagmus of man. Author

N67-39795# Federal Aviation Agency, Oklahoma City, Okla. Office of Aviation Medicine.

INTERAURAL INTENSITY DIFFERENCE LIMEN

Roy C. Rowland, Jr. and Jerry V. Tobias May 1967 14 p refs
(AM-67-10) CFSTI: HC $3.00/MF $0.65

The ability to judge the direction (the azimuth) of a sound source and to discriminate it from others is often essential to flyers. A major factor in the judgment process is the interaural intensity difference that the pilot can perceive. Three kinds of intensity-difference thresholds were compared for the purpose of determining interaural-binaural and interaural-monaural relations. Five subjects were tested at 250, 2000, and 6000 Hz, using a variation of the Bekesy technique. Responses to 27 interaural intensity combinations were measured at each frequency. Monaural and binaural conditions were included. Each of 24 of the combinations was measured under 0° and 180° interaural phase conditions, and all were measured at 50, 35, and 20 dB HL (ISO). Results indicate that interaural-difference thresholds decrease as a function of level, as might be predicted. These thresholds vary as a function of the frequency and apparent azimuth of the fused tone, but are relatively insensitive to variations in interaural phase. Interaural intensity-difference thresholds differ significantly from both monaural and binaural difference thresholds. Author

N67-39854# California Univ., Livermore. Lawrence Radiation Lab.

SOLUTION DENSITIES OF SODIUM CHLORIDE AS A FUNCTION OF TEMPERATURE AND ANHYDROUS SALT CONTENT

William L. Robison and Michael J. P. Weston 4 May 1967 107 p ref
(UCRL-50256) CFSTI: HC $3.00/MF $0.65

The International Critical Tables give the solution densities of sodium chloride as a function of anhydrous salt content at intervals of 2% and as a function of temperature at intervals of 10°C. A Lagrange polynomial generalized for two variables and requiring a double interpolation was used in conjunction with the data from these tables to generate tables with 0.1% intervals (from 1.00 to 20.90%) for anhydrous salt content and 0.1°C (from 0 to 36.3°C) for temperature. The density range is from ρ = 1.00047 to ρ = 1.16405. Author (NSA)

N67-39867# Federal Aviation Agency, Oklahoma City, Okla. Office of Aviation Medicine.
DIAGNOSTIC TESTS OF COLOR DEFECTIVE VISION Annotated Bibliography, 1958–1966
Mark F. Lewis and Faye K. Ashby May 1967 15 p refs
(AM-67-8) CFSTI: HC $3.00/MF $0.65

An annotated bibliography of 83 recent papers on diagnostic tests for color vision defects is presented. Three of the foreign-language articles have been translated. Procedures for obtaining copies of the translations are included. Author

N67-39929# Public Health Service, Washington, D. C. National Center for Air Pollution Control.
AIR QUALITY CRITERIA FOR SULFUR OXIDES
Mar. 1967 226 p refs
(PHS-Publ.-1619) GPO: $1.25

Sulfur dioxide and sulfur trioxide are easily formed during the combustion of sulfur in fossil fuels. About 25 to 30 parts of sulfur dioxide to each part of sulfur trioxide are formed. The other sulfur oxides are either difficult to form or are unstable so that they are not significant air pollutants. Sulfur dioxide is a relatively stable, non-flammable, non-explosive colorless gas that most people can detect at concentrations from 0.3 to 1 ppm in air. Sulfur dioxide can act as either a reducing agent or as an oxidizing agent, and it can react with materials in the air to form sulfur trioxide, sulfuric acid, and sulfate salts. It is highly soluble in water with which it reacts to form sulfurous acid. Sulfur trioxide reacts very rapidly with water to form sulfuric acid, its normal form in the atmosphere. Author

N67-39930*# Scientific Translation Service, La Canada, Calif.
THE EFFECTS OF ACCELERATED CENTRIFUGAL FORCE UPON THE DEVELOPMENT OF THE FROG EMBRYO. MORPHOLOGICAL CHANGES IN FROG EMBRYOS CENTRIFUGED IN VARIOUS DEVELOPMENTAL PHASES [DIE GESTALTUNGSVORGANGE DER IN VERSCHIEDENEN ENTWICKLUNGSSTADIEN ZENTRIFUGIERTER FROSCH-KEIME]
B. Konopacka Washington, NASA, Oct. 1967 38 p refs Transl. into ENGLISH from Polska Akad. Umiejetnosci, Rozprawy Wydzailu Mat. Przyrod. (Krakow), 1908 p 689–741)
(Contract NASw-1496)
(NASA-TT-F-11317) CFSTI: HC $3.00/MF $0.65 CSCL 06F

Experiments by the author on the effect of gravitational force on the development of frog eggs are compared with those of Pflüger conducted in 1883–84 and others. The author investigates the differential effects of centrifugal acceleration applied during various well-defined phases of early development of frog eggs and the consequences of these effects upon the further course of the development. Eggs of Rana Fusca were artificially fertilized in glass dishes. The eggs were subjected to a wide range of acceleration and temperature. Author

N67-39961 Joint Publications Research Service, Washington, D. C.
EFFECT OF IONIZING RADIATION ON CONDITIONED REFLEX ACTION
O. Ye. Voyevodina 24 Oct. 1967 23 p refs Transl. into ENGLISH from the book "Otdalennyye Rezul'taty Vozdeystviya Luchey Rentgena Na Vysshuyu Nervnuyu Deyatel'nost' Sobak" Leningrad, Med. Publ. House, 1967
(JPRS-43077; TT-67-33702) CFSTI: $3.00

The effect of different doses of X-rays on the complex motor-food conditioned reflexes in dogs formed by the Kupalov method of situation conditioned reflexes was investigated. The study established that the greater the complexity of the motor activity conditioned reflex developed in the animals, the more rapid is its disturbance under the influence of X-rays, and the greater is the delay of its resititution to its normal level. The conditioned motor activity reflex in the animals when restored to its normal level can again be disturbed even one to five years after the irradiation under the influence of different physiological and pharmacological factors. The offspring of females irradiated with doses of 200 to 300 rads show a prolonged decline in the work capacity of the central nervous system including the cerebrum. Different histological deviation from the norm are also noted in the cerebrum of these dogs. R.N.A.

N67-39963*# California Univ., Berkeley.
WORKSHOP CONFERENCE ON SPACE RADIATION BIOLOGY Final Report
Sep. 1965 30 p Conf. held in Berkeley, Calif., 7–10 Sep. 1965; sponsored by NASA
(NASA-CR-89581) CFSTI: HC $3.00/MF $0.65 CSCL 06R

The papers presented at a conference on space radiation and its biological effects are summarized. The topics of the papers included radiological physics, heavy ion effects on mammalian systems, space radiation hazards to man, molecular effects, an evaluation of the combined effects of radiation and other stresses in space flight, and cellular effects. R.N.A.

N67-39984# Army Medical Research Lab., Fort Knox, Ky. Biophysics Div.
SURFACE TEMPERATURE AS A PARAMETER IN ESTIMATING LASER INJURY THRESHOLDS Interim Report
George R. Peacock 8 Jun. 1967 26 p refs
(AMRL-733; AD-658967)

A simple model based on elevation of the surface temperature in biological tissue was formulated in an attempt to aid in estimating laser injury thresholds. The model shows reasonable agreement in the ranges where experimental data are available. This fact lends confidence to predictions of injury thresholds for other laser wavelengths and pulse length. Predictions are made in particular for eye injury in the visible and near infrared, for tissue burns in the mid- and far-infrared. Author (TAB)

N67-39985# Army Medical Research Lab., Fort Knox, Ky. Experimental Psychology Div.
THE SCALING OF EFFORT PRODUCED BY STRENUOUS ISOMETRIC MUSCLE CONTRACTIONS Progress Report
Lee S. Caldwell 8 Sep. 1967 6 p refs
(AMRL-749; AD-658979)

Thirty-five Ss were required to maintain manual loads equal to 30%, 40%, 50%, 60%, 70%, and 80% of their maximum strength as long as possible and to report the intensity of the effort required by the task on a five-point scale. With each increase in load, endurance was reduced and effort developed at an increased rate, showing that effort rating was sensitive to variations in contraction strength. External occlusion of the blood supply to the contracting muscles, especially at the lighter loads, also produced briefer maximum contraction times and accelerated the reports of the various levels of effort. The contraction strength at which the internal pressure in the muscle effectively occluded the blood supply was found to be between 60% and 70% of maximum strength. The data were transformed to eliminate differences in endurance produced by the various experimental conditions by expressing the time of appearance of each level of effort as a percentage of the time at which maximum effort was reported for that condition. When this was done, it was found that effort was a linear function of the percentage maximum contraction time. Author (TAB)

N67-40006* Scientific Translation Service, La Canada, Calif.
REGULARITY IN THE CORRELATION BETWEEN THE TRUE URINE REACTION AND THE ALVEOLAR CO_2 TENSION [UEBER GESETZMAESSIGKEITEN IN DER BEZIEHUNG ZWISCHEN DER WAHREN HARNREAKTION UND DER ALVEOLAREN CO_2-SPANNUNG]
Gustav Endres Washington, NASA, Oct. 1967 21 p refs Transl. into ENGLISH from Biochem. Z. (Heidelberg), v. 132, no. 1/3, 1922 p 220–241
(Contract NASw-1496)
(NASA-TT-F-11293) CSCL 06P

Fluctuations in hydrogen ion concentration in urine were studied and correlated with CO_2 tension in the arterial blood. The effect of various diets was investigated. The interpretation of post digestive fluctuations in urine acidity of K.A. Hasselbalch is refuted. The effect of morphium, coffein, muscle work and other factors is investigated. Author

N67-40010* National Aeronautics and Space Administration, Washington, D. C.
POSITIONAL RELATION OF SPERMIUM POINT OF ENTRY TO THE MEDIAN PLANE AND TO THE PRIMITIVE GROOVE AFTER LOCAL VITAL STAINING TESTS WITH THE AXOLOTL OVUM [DIE LAGEBEZIEHUNG DER SPERMIUMEINTRITTSSTELLE ZUR MEDIANEBENE UND ZUR ERSTEN FURCHE NACH VERSUCHEN MIT OERTLICHER VITALFAERBUNG AM AXOLOTLEI]
H. von Eggeling Oct. 1967 11 p refs Transl. into ENGLISH from Anat. Anz. (Jena) v. 63, 1967 p 198–209
(NASA-TT-F-11356) CSCL 06C

Experiments for determining the position of the spermium entry point in relation to the median plane and to the primitive groove, using local vital staining with agaragar as color base and using Axolotl ova, are discussed. The method is presented as more accurate and simple than previous ligation and other methods. Results indicate that a dorsoventral differentiation presumably exists already in the unfertilized ovum. Penetration of the spermatozoon, under assumption of a primary bilateral structure, occurs between production of the ovum symmetry and formation of the primitive furrow. Entry point of the spermium has no distinct relation to the ovum symmetry and the grooving pattern frequently follows the fertilization meridian in that the primitive groove coincides with this meridian independent of the ovum symmetry. Author

N67-40078# Massachusetts General Hospital, Boston. Stanley Cobb Labs. for Psychiatric Research.
RESEARCH ON INFORMATION PROCESSING IN THE CENTRAL NERVOUS SYSTEM Final Report, 1 Feb. 1962–31 Jan. 1966
Frank R. Ervin Bedford, Mass., AFCRL, Aug. 1967 108 p refs
(Contract AF 19(628)-408)
(AFCRL-67-0145; AD-658494)

An on-line computer controlled visual stimulation and computation of the post stimulus time histogram of single neurons in cat visual cortex was carried out. Three-hundred fifty cells are described as to temporal firing pattern and field response curves. In addition, the effects of background illumination and reticular formation stimulation were studied in a smaller number. These two variables were effective in modifying field response patterns primarily by modifying basal firing levels and excitability. The use of single spot stimulation suggests the existence of a receptive field which would show unique sensitivity to (simple) geometric form or motion without the convergent coding at the geniculate suggested in the literature. In addition, these fields prove to be capable of modulation by changing circumstance. This view of the structure of the visual cortex of the mammal necessitates some revision of simplistic models which have been advanced for hardware realization of pattern-recognizing artifacts. Author (TAB)

N67-40091*# New Mexico State Univ., Las Cruces.
MICROORGANISMS COLONIZING STRAWS BURIED IN CHILE DESERT SOIL SAMPLES
Eugene E. Staffeldt 25 Sep. 1967 12 p refs
(Contract JPL-951602)
(NASA-CR-89594) CFSTI: HC $3.00/MF $0.65 CSCL 06M

Sterilized plant parts were buried in three Chile Atacama Desert soil samples. These organic traps were removed from the soil samples, washed free of adhering soil particles, and plated onto the surface of agar contained in petri dishes. Two genera of fungi and four bacteria were isolated from the organic traps. Dilution techniques yielded information different from that obtained from the trap burial technique. Author

N67-40155* National Aeronautics and Space Administration, Washington, D. C.
DEPTH PERCEPTION AND HEAD MOVEMENTS
Ye. M. Belostotskiy Nov. 1967 7 p Transl. into ENGLISH from Probl. Fiziol. Optiki SSSR, v. 8, 1953 p 341–345
(NASA-TT-F-11360) CSCL 05J

Details are presented on experiments to investigate the dependency of depth perception on binocular and monocular vision and to determine the temporal features of depth perception combined with collateral stimuli. Two black needles with variable position were observed against a uniform white background in a depth ophthalmometric apparatus, with one and two eyes, with and without head motion. Head motion was found to have the greatest effect on depth perception and on the time threshold. A noise factor also had a marked influence on the time threshold. It was determined that the usual distinction between binocular and monocular types of depth perception is incorrect. N.E.N.

N67-40159* National Aeronautics and Space Administration, Washington, D. C.
CHANGES IN THE BONES OF THE EXTREMITIES AS A RESULT OF THE PROLONGED AND COMBINED INFLUENCE OF LOW TEMPERATURE AND HUMIDITY [IZMENENIYA V KOSTYAKH KONECHNOSTEY PRI DLITEL'NOM SOCHETANNOM VOZDEYSTVII NIZKOY TEMPERATURY I VLAZHNOY SREDY]
G. A. Orlov and K. M. Gavrilova Nov. 1967 9 p refs Transl. into ENGLISH from Klinich. Med. (Moscow), v. 43, Nov. 1965 p 15–19
(NASA-TT-F-11351) CSCL 06C

The extremities of 45 mice and 12 rats were cooled in water of 7–12° for 6 to 12 hours over a period of 2 to 7 days. Upon histological examination, the following changes were revealed: the development of edema in the soft tissues, the appearance of infiltrates and thromboses, periostitis, and reorganization of the lamellar structure of the bone. An X-ray investigation of the bones of the extremities was carried out in 67 patients whose occupations involved repeated cooling in water. In 65 cases, the following changes were found in the bone tissues: reorganization of the spongiose substance of the bone tissue of digital phalanges, bones of the feet and hands, the development of cysts, foci of osteosclerosis, periostitis, and moderately manifested deforming arthrosis. Author

N67-40172# Istituto Superiore di Sanita, Rome (Italy). Lab. di Fisica.
TECHNIQUES OF PURIFICATION OF FERRITIN AND CONJUGATION WITH ANTIBODIES FOR THE LABELING OF SPECIFIC PROTEINS UNDER THE ELECTRON MICROSCOPE [TECNICHE DI PURIFICAZIONE DELLA FERRITINA E CONJUGAZIONE CON ANTICORPI PER LA VISUALIZZAZIONE AL MICROSCOPIO ELETTRONICO DI PROTEINE SPECIFICHE]

K. Hsu 8 Mar. 1967 33 p In ITALIAN; ENGLISH summary
(ISS-67/8) CFSTI: HC $3.00/MF $0.65

The experiments hereby reported deal with the labeling of globulin with fluorescein and/or ferritin. All the techniques of purification of ferritin and globulin and of conjugation with ferritin and fluorescein are described in details together with an application at the electron microscope. Author

N67-40184*# Farnham (Frank C.) Co., Philadelphia, Pa.
PROTEINS (ANTIBODIES) WHICH REACT SPECIFICALLY WITH DNA DAMAGED BY ULTRAVIOLET RADIATION [BELKI (ANTITELA), SPETSIFICHESKI REAGIRUYUSHCHIYE S DNK, POVREZHDENNOY DEYSTVIYEM ULTRAFIOLETOVOGO IZLUCHENIYA]
V. K. Podgorodnichenko and A. M. Poverenny Washington, NASA, Nov. 1967 9 p refs Transl. into ENGLISH from Molekul. Biol., Akad. Nauk SSSR, Inst. Radiats. i Fiz. Khim. Biol. (Moscow), v. 1, no. 4, 1967 p 483–487
(Contract NASw-1497)
(NASA-TT-F-11340) CFSTI: HC $3.00/MF $0.65 CSCL 06C

Antibodies which react with UV-irradiated DNA (3×10^{-5}–10^{-6} erg/mm^2; 254 mμ) were produced in rabbits by immunization, as described by Plescia, Braun and Palczuk. These sera did not react directly with native, denatured, single-strand DNA nor with UV-irradiated RNA. Antibodies induced by UV-irradiated DNA (dose rate, 10^6 erg/mm^2) began to react with DNA exposed to UV at a dose rate of 3×10^5 erg/mm^2. Author

N67-40220*# National Aeronautics and Space Administration, Washington, D. C.
INVESTIGATIONS OF THE INFLUENCE OF HEAVY MUSCULAR WORK ON RENAL CAPACITY [UNTERSUCHUNGEN UEBER DEN EINFLUSS SCHWERER MUSKELARBEIT AUF DIE NIERENLEISTUNG]
Th. Benzinger Oct. 1967 7 p refs Transl. into ENGLISH from Arbeitsphysiol. (USSR), v. 8, 1935 p 142–146
(NASA-TT-F-11290) CFSTI: $3.00 CSCL 06S

Investigations on the influence of heavy muscular work on renal function, using the blood-urea clearance method, are discussed briefly with a tabulation of results obtained on 10 healthy test subjects during rest and heavy muscular work. Muscular work greatly influenced the urea clearance and caused a drop in renal function by as much as 25–75%. Water excretion, presumably by extrarenal processes, is influenced to a greater and more lasting extent than the urea excretion function. It is suggested to make urea clearance tests for diagnostic purposes only at bed rest. Author

N67-40237* Oregon State Univ., Corvallis.
SYSTEMATIC DESCRIPTION AND KEY TO ISOLANTS FROM HAWAIIAN SOILS Progress Report
W. B. Bollen and Karen M. Byers 20 Sep. 1967 55 p Prepared for JPL
(Contracts NAS7-100; JPL-950783)
(NASA-CR-89680) CSCL 06M

A systematic description is presented of isolants from the Hawaiian soils. A dichotomous key separates the individual isolants into groups; the descriptive charts are arranged in these groups. In addition to this dichotomous key is a list of the isolants and species designations in the order of the code numbers. Of the 43 isolants from the Hawaiian soils, 65.1% are bacteria, 27.9% are actinomycetes, and 7.0% are molds. Isolants numbering 33Ab, 34Bc, and 37Bd contained more than one type of bacterial culture. The 37Bd is the only one needing further separation. Of the surviving isolants that are bacteria, 80.8% belong to the genera *Bacillus* and 19.2% belong to the "soil diphtheroid" group of organisms. Author

N67-40267*# National Aeronautics and Space Administration, Washington, D. C.
MEDICAL BENEFITS FROM SPACE RESEARCH
[1967] 19 p
(NASA-EP-46) GPO: $0.20 CSCL 06E

Described and pictured are a number of devies and techniques which resulted from research discoveries and engineering innovations of the space program. Application of these benefits toward the advancement of medicine is shown. The functions of NASA's Office of Technology Utilization are briefly discussed. K.W.

N67-40284# Library of Congress, Washington, D. C. Aerospace Technology Div.
SPACE BIOLOGY AND MEDICINE: A NEW SOVIET JOURNAL, SPECIAL REPORT Surveys of Foreign Scientific and Technical Literature
Daniel M. Pyle 22 Nov. 1967 61 p refs
(ATD-67-37)

Abstracted data are presented on reports of original research and review papers dealing with problem areas in the field of bioastronautics. The topics covered include problems in selecting scientist cosmonauts, using spacecraft computers for medical purposes, creating life support systems for spacecraft, and human acceleration tolerance; space psychology experiments; spaceflight gastroenterology; spacecraft habitability; radiation safety; anoxic radiation resistance in potato plants; cardiac reactions to hypoxia; preventing cardiovascular reactions to hypokinesia; hypodynamia effect on protein synthesis; reflex hemodynamic regulation during acceleration; and vestibular stimulation effect on visual neurons. M.G.J.

N67-40290 Joint Publications Research Service, Washington, D. C.
BIOLOGICAL EFFECT OF THE COMBINED ACTION OF GAMMA RAYS AND SPACE FLIGHT FACTORS ON BARLEY SEEDS
N. I. Nuzhdin and R. L. Dozortseva 27 Oct. 1967 23 p refs Transl. into ENGLISH from Zh. Obshch. Biol. (Moscow), v. 27, no. 4, 1967 p 397–412
(JPRS-43155; TT-67-33780) CFSTI: $3.00

To assess the effect of space flight factors (SFF) on seed germination and frequency of chromosome aberrations, gamma irradiated and nonirradiated barley seeds in organic and forced dormancy were placed onboard the Voskhod I. Similar seeds served as the control. Some seeds were soaked in a cysteine solution before germination. The results showed that SFF undoubtedly produced genetic changes. The SFF were also found to (1) accelerate the emergence of the seeds from organic dormancy, differing in this respect from gamma irradiation; (2) have no effect on germination vigor or rate in seeds that were in a state of forced dormancy; (3) increase the number of aberrant cells, as compared with controls, in the primary rootlets of the seeds in forced dormancy, while having no effect on seeds in organic dormancy. Irradiation of seeds before and after spaceflight showed that gamma rays and SFF have an additive influence. Considered of fundamental importance to space biology was the finding that cysteine reduces the yield of aberrant cells induced by SFF. M.G.J.

N67-40294* Swift and Co., Chicago, Ill. Research and Development Center.
INTERIM REPORT FOR 12 MONTHS ENDING JULY 31, 1967
Harland H. Young 31 Jul. 1967 34 p
(Contract NAS7-487)
(NASA-CR-89746) CSCL 06A

Protein films of various thicknesses were prepared, using a superclear gelatin with a natural pH of 3.9 to 4.1, deaminated gelatin, carbamidated gelatin, cyanamidated gelatin, and phenol-formaldehyde resin gelatine condensate. Plasticizers, made up as aqueous solutions and colored for easy identification, were used in the films at various levels. These included ethylene glycol, polyethylene glycol, dimethylsulfoxide, N-methylpyrrolidone, and glycerol. The basic formula is given, and the preferred method of casting a film is detailed. Film samples were tested for helium transmission and tensile strength, and the results are tabulated. Data points were used to estimate the effects of gelatine, plasticizers, levels of plasticizers, and film thicknesses on gas transmission. Experimental data are also included on the use of crosslinking agents, which were added as 1.0% solutions to prevent premature gelatin. Consideration is also given to the use of reinforcing fibers, and the effects of ultraviolet irradiation, and heat and cryogenic temperature treatments on the films. M.G.J.

N67-40299# Naval Medical Research Inst., Bethesda, Md.
A REACTION VESSEL FOR USE IN GAS CHROMATOGRAPHIC ANALYSIS OF AQUEOUS SOLUTIONS. APPLICATION FOR BLOOD CARBON MONOXIDE DETERMINATION
Research Report
Frederick Lee Rodkey and Harold A. Collison 20 Mar. 1967 14 p refs
(Rept.-16; AD-659061)

A reaction vessel was designed and constructed for use in gas chromatographic analysis of gases liberated from aqueous solutions. The apparatus is a self contained attachment which replaces the standard gas sampling loop on the chromatograph. A single interchangeable glass tube with a ground glass joint is used and is convenient to prepare, clean and replace between analyses. Gas sweep-out characteristics of the vessel were tested with carbon monoxide liberated from a carboxyhemoglobin solution. A sweep-out period with the carrier gas of 1 to 3 minutes was shown to recover 99.4 to 99.7 per cent of the total CO originally present in the solution. The usefulness of the reaction vessel was demonstrated by the measurement of blood carbon monoxide content in a series of 74 hospital patients. Author (TAB)

N67-40329* National Aeronautics and Space Administration, Washington, D. C.
MEASUREMENTS OF THE PROTON DOSE OF THE GEMINI ASTRONAUTS WITH NUCLEAR EMULSIONS [MESSUNGEN DER PROTONENDOSIS DER GEMINI-ASTRONAUTEN MIT KERNEMULSIONEN]
H. J. Schaefer Oct. 1967 14 p refs Transl. into ENGLISH from Biophysik (Berlin), v. 4, 1967 p 63–76
(NASA-TT-F-11237) CSCL 06R

Results of proton dose measurements with nuclear emulsions, during various Gemini flights, are discussed as to their transitory or permanent effect on the organism. Photomicrographs of Ilford G.5 and K.2 nuclear emulsions and plottings of range spectra of ending particles indicate that the radiation received by the astronauts during passage through the South Atlantic anomaly of the radiation belt was produced to 40% by protons of a range of less than 1 mm tissue. The total (skin) dose received during the 14-day Gemini flight was about 200 millirad, varying between 159 and 233 millirad for the three test points on the astronaut body and showing a decrease in depth. No reliable determination of the true radiation stress and of the maximum permissible dose for whole-body irradiations was possible, but even skin doses of several 100 rad during passage through the center of the radiation belt would result in depth doses of not more than 10–20 rad. Author

N67-40433*# Farnham (Frank C.) Co., Philadelphia, Pa.
GENETIC STUDIES IN SPACE [GENETICHESKIYE ISSLEDOVANIYA V KOSMOSE]
G. P. Parfenov Washington, NASA, Oct. 1967 20 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 5, no. 1, 1967 p 140–155
(Contract NASw-1497)
(NASA-TT-F-11251) CFSTI: HC$3.00/MF$0.65 CSCL 06F

Review of Soviet and foreign papers on genetic studies in space covering the period from the late twenties through 1965. Discussed specifically are the results of free-balloon, rocket, and satellite experiments with microorganisms, plants, and animals. A brief analysis of these results is given. Author

N67-40465*# Scientific Translation Service, La Canada, Calif.
THE EFFECT OF VIBRATION ON THE MORPHOLOGIC PATTERN OF ENDOCRINE GLANDS [WPLYW WIBRACJI NA MORFOLOGICZNY ORBAZ GRUCZOLOW DOKREWNYCH]
Ryszard Piechocinski Washington, NASA, Oct. 1967 3 p refs Transl. into ENGLISH from Patol. Polska (Warsaw), v. 17, no. 4, 1966 p 561–563
(Contract NASw-1496)
(NASA-TT-F-11328) CFSTI: HC$3.00/MF$0.65 CSCL 06C

After vibration of frequency 1800/min and amplitude of 6 mm in the vertical and 4 mm in the horizontal direction, no changes were found in the thyroid gland or ovaries. The adrenal glands were enlarged, their medullary portion was hyperemic, and the zona fasciculata was slightly enlarged. The changes in the adrenal glands of white mice were attributed to stress connected with vibration. Author

N67-40652* National Aeronautics and Space Administration, Washington, D. C.
MECHANISM OF HEAT REGULATION [UEBER DEN MECHANISMUS DER WAERMEREGULATION]
Sp. Dontas Oct. 1967 18 p refs Transl. into ENGLISH from Arch. Ges. Physiol. (Berlin), v. 241, 1939 p 812–829
(NASA-TT-F-11275) CSCL 06C

Older concepts on the mechanism of heat regulation, according to which fever produces a stimulation of the heat centers and antipyretics have a narcotic effect, is disproved on the basis of experiments on animals in which the polypnea threshold and the thermal width were determined. It is demonstrated that fever produces a paralytic effect and a reduction in excitability of the heat centers and that any increase in excitability of the heat centers will cause an adjustment to lower body temperatures. The finding that the excitability of the heat centers is largely influenced by the water reserves of the organism is used as proof for the assumption that most paralytic or exciting factors are due to a water displacement. Proofs are offered for such effects of the water balance on the thermotaxic centers. Author

N67-40589# Joint Publications Research Service, Washington, D. C.
STUDIES OF THE VESTIBULAR APPARATUS OF HUMANS AND ANIMALS
5 Oct. 1967 35 p refs Transl. into ENGLISH from Vestn. Otorinolaringol. (Moscow), no. 4, 1967 p 3–22
(JPRS-42842; TT-67-33468) CFSTI: HC$3.00/MF$0.65

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N67-40570# Joint Publications Research Service, Washington, D. C.

THEORETICAL AND CLINICAL VESTIBULOLOGY

V. I. Voyachek *In its* Studies of the Vestibular App. of Humans and Animals 5 Oct. 1967 p 1–9 refs (See N67-40569 24-04)

A brief survey on the history of theoretical and clinical studies of vestibular reactions to various stimulations is given. The physiology of motion sickness, objectivization of labyrinth reflexes, vestibular stimulations and their functional patterns are briefly outlined from early studies up to the current space flight age. G.G.

N67-40571# Joint Publications Research Service, Washington, D. C.

FUNCTIONS OF THE VESTIBULAR ANALYZER IN CONNECTION WITH SPACE FLIGHT

K. L. Khilov *In its* Studies of the Vestibular App. of Humans and Animals 5 Oct. 1967 p 10–22 refs (See N67-40569 24-04)

Screening for space flight service by comparing vestibular sensitivity of pilots takes place by subjecting applicants to Kepler trajectory flights in jets. During rapid climbing and acceleration up to 5 g, terrestrial gravity is overcome and a state of weightlessness occurs that lasts up to 35 seconds. Coriolis acceleration effects on the function of the semicircular canals of the vestibular organ can be tested by rotating the applicant on a centrifuge, or by detecting latent sensitivities to Coriolis acceleration through chloral hydrate intake before acceleration tests. Subjects are most sensitive to the acceleration effect when their head and trunk are inclined backward on the centrifuge. Acceleration on swings with sudden stop and go situations is recommended for testing resistance ability to sudden g forces, and a combination of tests for a final selection. If after administration of 20 ml of a 5% chloral hydrate solution the subject retains stability of his vestibular analyzer to stimuli, then this candidate is fully qualified to serve as an astronaut. G.G.

N67-40572# Joint Publications Research Service, Washington, D. C.

INTERRUPTION OF THE FUNCTION OF OTOLITHIC FORMATIONS BY MEANS OF IONIZING RADIATION

N. I. Arlaschenko, Yu. G. Grigor'yev, and A. B. Malinin *In its* Studies of the Vestibular App. of Humans and Animals 5 Oct. 1967 p 23–31 refs (See N67-40569 24-04)

Applicators saturated with a radioactive isotope were introduced into the vestibular perilymphatic space of rabbits in order to observe sensitivity to radionecrosis of the inner ear tissue. The first vestibular reactions were those typical of receptor function suppression and the appearance of nystagmus; accumulation of radiation energy by the tissues surrounding the radioactive source later interrupted ampular apparatus functions, induced distinct turning and inclination of the animal's head, and caused the complete death not only of the otolithic, but also of the ampular apparatus. G.G.

05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences.

N67-39509*# Northeastern Univ., Boston, Mass. Electronics Research Lab.

A STUDY OF MICROMINIATURIZED DEVICES FOR BIOASTRONAUTICAL MONITORING OR ANALYSIS

Semiannual Report

Basil L. Cochrun and J. Spencer Rochefort 1 Sep. 1967 21 p refs

(Grant NGR-22-011-024)

(NASA-CR-89831; SAR-1) CFSTI: HC $3.00/MF $0.65 CSCL 06B

A literature survey and instrumentation evaluation was conducted to determine feasibility of developing an improved, lightweight apparatus for measuring hemoglobin in the ear with non-invasive instruments. Problems associated with obtaining ear measurements are discussed. Laboratory techniques for transmission measurement of blood parameters are reviewed and analytic expressions are developed. Two commercial instruments for laboratory measurement of the percent of oxyhemoglobin present in whole blood and a commercial ear oximeter were evaluated. The advantages of solid state light sources over incandescent sources in monitoring devices are examined. The use of microminiaturized integrated circuit technology to develop a modular electrode buffer amplifier is considered. E.C.

N67-39549# Rutgers Univ., New Brunswick, N. J. Douglass Coll.

CONCEPTUAL STRUCTURE AND INTERPERSONAL ATTRACTION

Siegfried Streufert, Carl Castore, Susan Kliger, and Michael J. Driver (Purdue Univ.) Aug. 1967 29 p refs

(Contract N00014-67-0115-0002)

(TR-4; AD-657942)

The social choices of subjects differing in complexity of conceptual structure were obtained for a number of hypothetical situations: (1) at a party, (2) under the leadership of...(3) leading, (4) in an academic task. Choices for each condition were factor analyzed. It was found that structural complexity accounts for one quarter to one third of the variance in social choices and that factor defined groups for each condition differ in complexity. It was further found that structurally complex persons generally make more choices than structurally simple persons. Further, the results serve to refute the position of Calhoun that patterns of interpersonal choice are due to random mathematical order. Author (TAB)

N67-39611# Naval Air Development, Johnsville, Pa. Aerospace Medical Research Dept.

EVALUATION OF A WET SUIT IN CONJUNCTION WITH ANTI-BLACKOUT PROTECTION

Robert M. Patton 3 Aug. 1967 14 p

(NADC-MR-6713; AD-658508)

An investigation was undertaken to test and evaluate a wet suit worn in conjunction with the Mark II anti-G suit under acceleration. Eight subjects were run on the centrifuge under conditions of no protection, wearing an anti-G suit only, wearing an anti-G suit under the wet suit, and wearing the anti-G suit over the wet suit. Results indicated that acceleration tolerance was significantly improved by the use of the anti-G suit, but there was no statistically reliable difference between the anti-G suit only and the two anti-G suit/wet suit combinations. Author (TAB)

N67-39724# Federal Aviation Agency, Oklahoma City, Okla. Office of Aviation Medicine.

DEVELOPMENT OF TECHNIQUES FOR EVALUATING THE PHYSIOLOGICAL PROTECTIVE EFFICIENCY OF CIVIL AVIATION OXYGEN EQUIPMENT

Ernest B. McFadden Apr. 1967 17 p refs
(AM-67-3)

The two alternative methods of determining mask performance based on gas analysis and blood oxygen saturation were used simultaneously in this study for comparison. Evaluation of newly developed crew oxygen masks was divided into three phases. The first phase consisted of exposing the subjects to a stepwise flight profile with a maximum altitude of 43,000 feet while wearing the mask. The second phase consisted of rapidly decompressing the subjects from 8,000 to 40,000 feet in 45–50 seconds while wearing the mask. The third phase consisted of rapidly decompressing these subjects from 8,000 to 40,000 feet with delayed donning of the mask during the decompression. Instrumentation of subjects provided for simultaneous determination of seven physiological parameters during decompression which are compared and discussed. Results of these experiments indicate that, insofar as design standards are concerned, the present criteria based on inspired oxygen partial pressure are satisfactory, but should be supplemented by determination of blood oxygen saturation during chamber evaluations. Author

N67-39783*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

DEVELOPMENT OF RESPIRATION-RATE TRANSDUCERS FOR AIRCRAFT ENVIRONMENTS

Robert T. McDonald (Northrop Corp., Anaheim, Calif.) and James Roman Washington, NASA, Oct. 1967 17 p refs
(NASA-TN-D-4217) CFSTI: HC $3.00/MF $0.65 CSCL 06B

Two types of sensors for monitoring respiration rate in aircraft environments have been developed: a low pressure pneumotachometer designed to monitor the pilot's respiration rate in aircraft that have low pressure breathing-oxygen supply, and a high pressure pneumotachometer designed to monitor the pilot's respiration rate in aircraft with a high pressure breathing-oxygen supply. For both pneumotachometers, the sensor is placed in series with the oxygen supply line and the pilot's oxygen line. The sensor detects gas flow that accompanies inspiration. The pneumotachometers were tested in the laboratory and in high performance aircraft. The sensors are sensitive to gas flow and can detect a shallow breath. Each of the sensors requires very low power consumption and is thus suited for use with internally powered tape recorders. Author

N67-39794# Northrop Space Labs., Hawthorne, Calif.

PRESSURE SEALING CLOSURES FOR FULL PRESSURE PROTECTIVE SUIT ASSEMBLIES Final Report, 15 Jul. 1966–10 Feb. 1967

Roger M. Heitz and Gary G. Brown Wright-Patterson AFB, Ohio. AMRL, Jun. 1967 52 p refs
(Contract AF 33(615)-5372)
(AMRL-TR-67-59; AD-658204)

Longitudinal and circular pressure sealing closures were designed and developed for full pressure protective assemblies from a design concept provided by the Aerospace Medical Research Laboratories, invention disclosure number 66/588. This study consisted of (1) designing pressure closure devices, (2) selecting suitable materials for the fabrication of the sealing closure parts and the cylinders to include the closures, (3) selecting an appropriate fabrication process for the closure sealing parts, and (4) fabricating and testing the breadboard and demonstration models containing either the circular or longitudinal closures. An EPDM elastomeric material was found to be suitable for the fabrication of the closure sealing parts which were molded using an established molding technique. The fabricated breadboard and demonstration models passed successfully the required tests wherein leak rates were determined from 0 to 5 psig, and exposure to pressure up to 12 psig, were performed. Author (TAB)

N67-39884# Federal Aviation Agency, Oklahoma City, Okla. Office of Aviation Medicine.

PERFORMANCE CHARACTERISTICS OF CONSTANT-FLOW PHASE DILUTION OXYGEN MASK DESIGNS FOR GENERAL AVIATION

Ernest B. McFadden, Hiley F. Harrison, and James M. Simpson May 1967 15 p refs
(AM-67-9) CFSTI: HC $3.00/MF $0.65

This report describes evaluation of two prototype phase dilution rebreathing masks as compared to an open port rebreathing mask design. Human subjects wearing the prototype masks and engaged in three minute periods of rest and exercise were exposed to altitudes of 14,000, 18,000, 25,000, 30,000 and 34,000 feet in an altitude chamber. Each subject was instrumented to obtain a variety of physiological parameters including end expiratory gas composition, blood oxygen saturation, ECG, and respiratory rate. Oxygen flow and system pressure as provided by an automatic constant-flow regulator were also determined. With the same oxygen flow rates the prototype porous and dilution valve masks provided higher tracheal oxygen partial pressures than the open port masks at all altitudes tested during rest and exercise. Author

N67-39885# Federal Aviation Agency, Oklahoma City, Okla. Office of Aviation Medicine.

A FUNCTIONAL COMPARISON OF BASIC RESTRAINT SYSTEMS

Joseph W. Young Jun. 1967 17 p
(AM-67-13) CFSTI: HC $3.00/MF $0.65

The problem of body restraint during accident event is pursued by this study. Since the greatest frequency of serious injuries occurs from upper body components (head, neck and chest) impacting or being penetrated by rigid, uneven surfaces, it is desirable and essential to restrain the body and prevent interaction with the surrounding structures. The functional characteristics of eight complete (seat belt and shoulder harness) restraint systems and a typical incomplete (seat belt only) system are presented graphically for comparison in a series of figures based on kinematic head patterns. An additional series compares the relative differences in restraining qualities that result from varying the attachment locations of an incomplete (seat belt only) system. Author

N67-39889*# Franklin Inst., Philadelphia, Pa. Research Labs.

[RESEARCH IN LIFE SCIENCES INSTRUMENTATION PERTINENT TO STUDIES IN SPACE BIOLOGY] Quarterly Report, 1 Jul.–30 Sep. 1967

R. M. Goodman 30 Sep. 1967 8 p
(Contract NSR-39-005-018)
(NASA-CR-89600; Q-B2299) CFSTI: HC $3.00/MF $0.65 CSCL 06B

The first brain probe assembly was evaluated with respect to sterilizability and configuration and found to be satisfactory. All probes are now complete and coated with silastic using stannous octuate as the catalyst. The electronic system was frozen and is well into fabrication. Multichannel telemetry efforts were concerned with an investigation of a new modulator. Current drains on the order of 9×10^{-6} amperes are obtainable and frequency sensitivities on the order of 1 to 2% per millivolt seem realizable. Study has continued on the design of means to obtain both uniform fields above ambient earth's field and shielding to obtain fields very much below the earth's field. In this repsect, previous papers are being re-examined which are concerned with applying computer techniques to produce tables from which shields could be easily designed and with the use of Helmholtz or Helmholtz type coils to produce accurate and uniform fields. R.N.A.

N67-39886# Honeywell, Inc., St. Paul, Minn. Systems and Research Center.
AUTOMATIC TEMPERATURE CONTROL FOR LIQUID-COOLED FLIGHT SUITS Final Report, Jun. 1966–May 1967
Glen L. Merrill and James B. Starr Johnsville, Pa., Naval Air Develop. Center, 3 Aug. 1967 83 p refs
(Contract N156-48547)
(Rept.-12045-FR1; NADC-AC-6702; AD-655834)

An automatic control system for maintaining constancy of skin temperature (T sub s) has been shown to be feasible by using special sensors to detect changes in T sub s and proportional fluid amplifiers to regulate the temperature of water flowing through the tubing of a water-cooled undergarment. Tests have indicated the response of the system when T sub s increased due to exercise or to an external heat load. Author (TAB)

N67-39898*# University of Southern Calif., Los Angeles. Dept. of Electrical Engineering.
SYNTHESIS AND IDENTIFICATION OF MATHEMATICAL MODELS FOR THE DISCRETE CONTROL BEHAVIOR OF HUMAN OPERATORS
M. J. Merritt May 1967 201 p refs
(Grant NGR-05-018-022)
(NASA-CR-89634; USCEE-202) CFSTI: HC $3.00/MF $0.65 CSCL 05H

This report describes the synthesis and identification of mathematical models which characterize the discrete control behavior of human operators. This type of behavior occurs in control situations where the human operator must decide between a small number of alternatives, while generating continuous control actions at the same time. In this report a systematic treatment of discrete control actions is made possible by the use of two types of hybrid elements. One accepts continuous inputs and produces binary outputs, while the other has continuous inputs and produces continuous outputs under the control of binary signals. Decisions to initiate an action, throw a switch, or select which switch out of a group of switches should be operated are described by a Multi-State Decision Element (MSDE). Decisions concerning the magnitude of a discrete control action, the length of a control interval, etc. are modeled by a Proportional Decision Element (PDE). Procedures and digital computer programs for the complete identification of both types of elements are given. The two elements are applied to the modeling of human operators performing compensatory tracking of gaussian random inputs. Two experiments were performed. Author

N67-39978*# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
STUDIES OF MULTIVARIABLE MANUAL CONTROL SYSTEMS: TWO-AXIS COMPENSATORY SYSTEMS WITH SEPARATED DISPLAYS AND CONTROLS
William H. Levison and Jerome I. Elkind Washington, NASA, Oct. 1967 131 p refs
(Contract NAS2-3080)
(NASA-CR-875; Rept.-1459) CFSTI: HC $3.00/MF $0.65 CSCL 05H

A series of two-variable manual tracking experiments was performed in which subjects were required to view two separated displays and operate two control devices to control the system. Performance was measured as a function of the display separation, the forcing function bandwidth, the task difficulty and the controlled-element dynamics. Human controller describing functions, eye movement distributions, and normalized mean-squared tracking error were obtained. Measurements were obtained when a single variable was viewed foveally, when a single variable was viewed peripherally, and when both variables were controlled simultaneously. The primary difference between the 1-axis foveal, 1-axis peripheral, and 2-axis human controller describing functions in all experiments was a difference in the low-frequency gain. These gain differences were generally consistent with the NMSE differences. Author

N67-40020# Army Medical Research Lab., Fort Knox, Ky. Experimental Psychology Div.
CROSS-MODALITY ESTIMATION OF ANGULAR VELOCITY Interim Report
James H. Brown 26 Jun. 1967 13 p refs
(AMRL-738; AD-658657)

The exponent of 1.0 found previously for numerical magnitude estimates of angular velocity during passive rotation was validated by auditory cross-modality estimates. Acceleration intensities ranged from 3 degrees/sec sq to 24 degrees/sec sq, with durations varying from 10 sec. to 80 sec. It was concluded that adaptation evident in responses to the longer duration stimuli is a real phenomenon and of potential significance as one form of disorientation. Author (TAB)

N67-40080*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
VISION IN SPACE TRAVEL
V. Popov and N. Boyko Redstone Arsenal, Ala., Redstone Sci. Inform. Center, 9 Aug. 1967 13 p Transl. into ENGLISH from Aviats. i Kosmonavt. (Moscow), no. 3, 1967 p 73–76 Prepared jointly with Army Missile Command
(NASA-TM-X-60574; RSIC-698) CFSTI: HC $3.00/MF $0.65 CSCL 05H

Laboratory experiment results and Voskhod flight data are compared in an attempt to assess the effect of supersonic and space travel conditions on the functional abilities of pilots and astronauts to detect light signals and to identify different types of visible shapes. Tests included measurements of vision sharpness, vision efficiency, perception characteristics of colors of objects, and observations of the earth's surface. It was found that the level of functional stability of chromatic vision is substantially affected by a series of conditions such as color, adaptation, simultaneous and subsequent contrast, and comparison features. Definite changes are also found in the functional abilities. The point is made that the peculiar behavior of human vision in space must be considered in instrument design and in astronaut training programs. M.G.J.

N67-40096*# Michigan Univ., Ann Arbor.
MEASURING HUMAN PERFORMANCE WITH A PARAMETER TRACKING VERSION OF THE CROSSOVER MODEL
Glenn A. Jackson Washington, NASA, Oct. 1967 253 p refs
(Contract NASr-54(06))
(NASA-CR-910) CFSTI: HC $3.00/MF $0.65 CSCL 05H

A continuous parameter tracking system is developed using an approximate version of the crossover model as the basic system model. The parameter tracking system is designed to adjust automatically the gain and time-dealy parameters so that the instantaneous value of the square of the error between the model output and the compensatory system output is driven toward zero. The parameter tracking system is tested on subjects controlling single and double integrator plants, with input signals of bandwidth limited Gaussian noise. The gain and time-delay parameters are found to change significantly with training and with the bandwidth of the input signal. The parameters also vay between subjects and with the order of the plant being controlled. A theoretical analysis of the system shows that the convergence properties of the parameters can be calculated when the input signal is sinusoidal and the system is tracking a known constant coefficient system. Author

N67-40136*# Allied Research Associates, Inc., Concord, Mass.
REVIEW OF BIOLOGICAL MECHANISMS FOR APPLICATION TO INSTRUMENT DESIGN, VOLUME V
J. Healer, ed. Aug. 1967 97 p refs
(Contracts NASw-1515; NASr-16; NASw-535, NASw-1228)
(NASA-CR-89601; ARA-346-F-2, Vol. V, Pt. 1) CFSTI: HC $3.00/MF $0.65 CSCL 06D

The results are summarized of a review of biological photoreception, mechanoreception, chemoreception, and electrosensing mechanisms for application to instrument design and engineering. Structural, functional, and operational principles of various classes and types of biosensors as they occur throughout the animal phyla are analyzed and the principles are evaluated from a bionic viewpoint against a background of current and anticipated instrumentation requirements and techniques. R.N.A.

N67-40236* Allied Research Associates, Inc., Concord, Mass.
BIBLIOGRAPHY ON BIOSENSORS. A SAMPLING OF THE WORLD LITERATURE 1960–1966, VOLUME V
J. Healer Aug. 1967 321 p
(Contract NASw-15115)
(NASA-CR-89616; ARPA-346-F-2, Vol. V, Pt. 2) CFSTI: $3.00 CSCL 06B

Biosensor phenomenology is stressed in a bibliography based on a sampling of the world literature between 1960 and 1966 that is referenced according to the categories of (1) mechanoreceptors, (2) photoreceptors, (3) chemoreceptors, (4) thermoreceptors, (5) electric and magnetic field sensors, (6) general sensor information, (7) neural aspects of sensor function, and (8) miscellaneous. Journal code translations and a user's guide are included in this bibliography which lists authors, titles, and sources of document. M.W.R.

N67-40239# Illinois Univ., Urbana. Group Effectiveness Research Lab.
MULTIMODE FACTOR ANALYSIS OF INTERPERSONAL PERCEPTIONS
Earl E. Davis and Nadine Natker Grobstein Dec. 1966 47 p refs
(Contract Nonr-1834(36); ARPA Order 454)
(TR-36; AD-658515)

Data resulting from the interpersonal perceptions of 88 students who were heterogeneous with respect to race and sex were subjected to a variety of analyses, including Tuckers three-mode factor analysis procedure. Ss responded on Semantic and Behavioral Differential scales to complex person stimuli designated in terms of race, sex, and other characteristics which formed a factorial design. The data were reduced to a two-way classification of scales-by-stimuli, using Ss mean group responses, and conventional factor analyses of scales were performed. Analyses of variance were carried out to determine the relative weights of the stimulus factors in determining the responses of the various groups of Ss on the scale factors. Finally, the three modes of the data classified in terms of scales-by-stimuli-by-subjects were subjected to Tuckers three-mode factor analysis. After obtaining principal axis factors for the three modes, the scale and subject mode factors were rotated by Varimax and the stimulus mode factors were transformed by means of discriminant function analysis. Counter-rotations of the three modes yielded a core matrix linking the scale factors to the stimulus factors. Although not all of the subject types were clearly interpretable in the present study, this type of analysis, with some modifications, would appear to have great potential value in treating complex interpersonal perception data. Author (TAB)

N67-40256*# Honeywell, Inc., Minneapolis, Minn. Systems and Research Center.
RESEARCH ON COMPUTATIONAL AND DISPLAY REQUIREMENTS FOR HUMAN CONTROL OF SPACE VEHICLE BOOSTERS. PART I: THEORY AND RESULTS Final Report, 1 Mar.–31 Aug. 1967
J. D. Gilchrist and P. A. Anderson Aug. 1967 135 p refs
(Contract NAS8-20023)
(NASA-CR-89606; Rept.-12513-FR3-I, Pt. I) CFSTI: HC $3.00/MF $0.65 CSCL 05H

The purpose of this study was to develop minimum computational and display requirements which will allow the full utilization of a human pilot's capabilities to perform the boost guidance function during the ascent phase in an efficient and near-optimal manner. In this volume, a three-dimensional Earth model for the Reusable Orbital Transport (ROT) vehicle was simulated. The Nominal Guidance Scheme was used for the first-stage guidance, the Predictive Model Guidance Scheme (PMGS) for the second-stage guidance. The mathematical model used for the real-time simulation of the ROT vehicle is discussed, and the equations of motion, written in a wind-axis coordinate system assuming a spherical rotating Earth, are presented. Also included are the target orbit, guidance plane geometry, and the equations of motion for the fast-time model required in the PMGS. Results of the operator work load measurement and display format evaluation are given in addition to computational and display requirements. K.W.

N67-40288# Space-General Corp., Los Angeles, Calif.
ELECTRICAL COUPLING AND NORMAL MODES OF OSCILLATION IN DENSE EXCITABLE CELLULAR STRUCTURES First Status Report, 1 Apr.–1 Jul. 1967
Robert M. Stewart Aug. 1967 54 p refs
(Contract N00014-67-C-0361)
(SG-1198/SR-1; AD-659519)

An experimental study, largely using simple inorganic electrochemical models, of structural and electrical characteristics which lead, through the agency of electrical fields, to intercellular transmission of excitation or information and to intrinsic oscillations (both sub- and suprathreshold) in dense arrays of both biological neurones and neuron-like data-processing elements as now being developed. Such periodic phenomena are presumed to have both physiological and pathological significance in (normal and abnormal) brain function, but are, as yet, only little understood. Author (TAB)

N67-40317*# Biotechnology, Inc., Arlington, Va.
DEVELOPMENT OF AN IMPROVED PERCEPTUAL-MOTOR PERFORMANCE MEASUREMENT SYSTEM
Raymond E. Reilly and James F. Parker, Jr. Aug. 1967 55 p
(Contract NASw-1329)
(NASA-CR-89613) CFSTI: HC $3.00/MF $0.65 CSCL 06B

This report describes the development and fabrication of three units of a perceptual-motor performance measurement system. The measurement system, consisting of a subject console and an experimenter console, is designed to measure 18 basic dimensions of human perceptual-motor performance. The present system represents an improved version of an earlier measurement console built under a prior NASA contract. Improvements are primarily in the areas of (1) separation of the subject and experimenter functions, thereby making the device more useful as an item of research equipment, (2) increased reliability during sustained operations, and (3) better design for maintainability. Author

N67-40339# Aerospace Medical Div., Aerospace Medical Research Labs., (6570th), Wright-Patterson AFB, Ohio.
TWO-HANDED RETENTION ON VARIOUS HANDLE CONFIGURATIONS

John W. Garrett, Milton Alexander, and William G. Bennett May 1967 23 p refs
(AMRL-TR-67-63; AD-658441)

Data are presented on the manual grip-retention capability of seated persons. Nine male subjects, grasping experimental ejection actuators located forward of an ejection seat pan, were required to maintain their grasp against force loadings of 50 to 500 pounds. Grip retention at various increments of time to a maximum of 30 seconds are compared for each of the four handles: a T-bar, Twin grips, a standard D-ring and a flexible Gemini-type loop. Test results indicated that the T-bar provides the greatest grip-retention capability. Potential applications of these performance data are discussed. Author (TAB)

N67-40344# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
VISUAL ACUITY DURING VIBRATION AS A FUNCTION OF FREQUENCY, AMPLITUDE AND SUBJECT DISPLAY RELATIONSHIP Final Report, Jul. 1965–Jun. 1966
L. Rubenstein and H. A. Taub Wright-Patterson AFB, Ohio, AMRL, Jun. 1967 25 p refs
(Contract AF 33(657)-11729)
(AMRL-TR-66-181; AD-658440)

Visual acuity during whole body Z-axis vibration (while in a semi-supine position) was measured as a function of frequency and amplitude of the input vibration, two restraint configurations (with or without a bite-bar), and two subject-display relationships (subject alone vibrating, and subject and display both vibrating). The results indicated an interaction between frequency of vibration and the restraint variable in their effects on visual acuity. Visual acuity suffered greater decrement with the bite-bar than without it, and the degree of this difference increased with increasing frequency. The effects of these variables were quite similar for both subject-display relationships. The report also describes the development of the method which was used to measure visual acuity. This is a vernier technique which makes use of a varying contrast ratio between the visual target and the background. Author (TAB)

N67-40350# North American Aviation, Inc., Columbus, Ohio.
PROBABILITY INDEXES OF IMAGE INTERPRETER PERFORMANCE: DEVELOPMENT AND EVALUATION
Girard W. Levy, Leonard A. Evans, John H. Humes, and Robert Sadacca (Army Behavioral Sci. Res. Lab.) Washington, Army Behavioral Sci. Res. Lab., Jun. 1967 88 p refs *Its* Tech. Res. Note 183
(Contract DA-092-ARO-47)
(AD-658653)

The study was conducted in a two-phase project to explore the development of indexes predictive of interpretation results and the effect on performance of probabilistic feedback given interpreters while they are examining imagery. Statistical treatment and analysis of data, based on the judgment and performance of trained interpreters, is described in detail. The ten best predictors of accuracy of target identification and the eight best predictors of the value of continued search (search utility) were identified and their predictive validity assessed in a three-session experiment. The predictors contributing most to the validity for accuracy of performance were (1) judged target difficulty and (2) interpreters confidence in his identifications. Predictors of search utility were of generally low validity. More effective prediction was obtained for target identification than for target detection or classification. It was found that feedback of both accuracy and search utility probability data reduced the number of incorrect identifications. Overall individual accuracy, completeness, or rate of interpretation was not affected, however, by feedback. Based on the findings in this study, it seems feasible that interpreters accuracy predictions can be substituted for confidence ratings now used as more precise indications of dependability of the information. Predictions have some utility also in weighting indentifications made by several interpreters or in conjunction with relative estimated cost errors--omissions vs misidentifications--in selecting among response alternatives within an image interpretation facility. Author (TAB)

N67-40357# Tufts Univ., Boston, Mass. Inst. for Psychological Research.
HUMAN FACTORS ENGINEERING BIBLIOGRAPHIC SERIES. VOLUME 3: 1965 LITERATURE
Paul G. Ronco Aberdeen Proving Ground, Md., Human Eng. Labs., May 1967 543 p refs
(Contracts Nonr-494(13); DA-18-001-AMC-1004(X))
(AD-657590)

This bibliography is the third in a planned series of bibliographies of literature pertinent to the field of human factors engineering. It covers literature of 1965. This bibliography consists primarily of: (1) an index to the human factors literature, and (2) the annotated bibliography. TAB

N67-40370# Chicago Univ., Ill. Committee on Mathematical Biology.
STATISTICAL MECHANICS OF NEURAL NETWORKS
Jack D. Cowan [1967] 105 p refs
(Contract F61052-67-C-0061)
(AD-658886)

A mathematical model is developed of the activity of networks of model nerve-cells or neurons. A nonlinear delay operator is introduced to represent the transfer characteristics of neurons. This operator is a continuous function that represents the mean neuronal response to stimulating currents. The mathematics used is not the Boolean algebra of switching circuits, but Differential equations. The dynamics is examined of certain model brain circuits, some of which are shown to exhibit undamped responses to stimuli, but only for a few levels of activity. The techniques of Hamiltonian mechanics and of Gibbsian statistical mechanics are used to connect these models with experimental data. A preliminary explanation is given for the existence of preferred states found in the firing patterns of neurons in animal nervous systems. Author (TAB)

N67-40406# Franklin Inst., Philadelphia, Pa. Systems Science Dept.
EXPERIMENTS IN DISPLAY EVALUATION
Daniel Landis, Robert M. Slivka, James M. Jones, and Carl A. Silver Jul. 1967 89 p refs
(Contract Nonr-4832(00))
(TR-1-194; AD-658733)

Four experiments were performed with the following objectives: (1) further explore a proposed method of display evaluation; (2) relate the proposed method to conventional measures of display goodness; (3) examine the effects of three types of informational irrelevancy on decision adequacy; and (4) test a hypothesis relating to the effects of compressing discrete informational units onto single symbols. In all experiments except those related to objective 2, the subjects task was to make a military-type decision based on information presented on the display. Two decision-game formats were used; the first was logistical while the second used an air-reconnaissance situation. In these studies, each decision the subject made was associated with an explicit cost-payoff function. Since each problem required a series of such decisions, a weighted sum of the payoffs, minus the costs, was the method of display evaluation. Each of several display variables (such as density, use of color, or clutter), and response variables (such as search time) was related to cost-payoff scores, depending on the experiment. Major conclusions were that the decision-quality metric is potentially useful for evaluating display systems, and that information-extraction measures apparently are unrelated to the metric. It was also revealed that the effectiveness of a display is positively related to the amount and randomness of irrelevant information presented in the display. Author (TAB)

N67-40458* Hamilton Standard Div., United Aircraft Corp., Windsor Locks, Conn. Space and Life Systems Dept.
STUDY TO RELATE APOLLO SPACE SUIT TECHNOLOGY TO THE FIELD OF HYPERBARIC MEDICAL THERAPY
25 Mar. 1966 123 p
(Contract NASw-1271)
(NASA-CR-89671) CSCL 06B

Application of various NASA-sponsored space technologies to the field of hyperbaric medicine was studied. Considered were the needs of diving and aviation operations and hyperbaric medical facilities. Domestic and foreign chamber systems were studied, and two portable, collapsible hyperbaric chamber system concepts were designed for routine decompression and treatment of dysbarism associated with diving operations. The two concepts are: (1) a two-man, one-lock chamber incorporating foam-filled fiberglass sandwich and convoluted rubber-impregnated fabric construction; and (2) a two-man, two-lock chamber of fiberglass sandwich separable into two individual one-lock chambers without pressure loss. The two chamber designs also possess the capability for limited use in oxygen therapy of other pathology. Target engineering and medical specifications were compiled for the design and analysis work, and comparative weight studies using other materials as well as rigid and collapsible configurations were performed. Closed loop and open loop environmental control systems for these chambers were studied, and two respective approaches are proposed. The utilization of bio-instrumentation with these chambers was also investigated. It is concluded that a definite need exists for portable hyperbaric chamber systems with a two-man capability. K.W.

06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

N67-39384# Lincoln Lab., Mass. Inst. of Tech., Lexington.
GROWTH OF SINGLET Ti_2O_3 CRYSTALS FROM THE MELT
Thomas B. Reed, Robert E. Fahey, and Jurgen M. Honig 11 Aug. 1967 12 p refs
(Contract AF 19(628)-5167)
(ESD-TR-67-343; TN-1967-38; AD-657978)

Procedures are described for growth of large single crystals of TiOx, (1.501 < or = x < or = 1.512) that are reasonably free of cationic impurities and of C and N. Data concerning the stoichiometry and the segregation of impurities during crystal growth are presented. The electrical properties of doped and pure single crystal materials are briefly described. Author (TAB)

N67-39417 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
THE THERMODYNAMICS OF CATION EXCHANGE OF ALKALI METALS ON SULFONIC AND PHENOLSULFONIC RESINS [TERMODYNAMIKA WYMIANY KATIONOWEJ METALI ALKALICZNYCH NA JONITACH SULFONOWYCH I FENOLOSULFONOWYCH]
Rajmund Dybczynski 1967 24 p refs Transl. into ENGLISH from Polish Submitted for publication
(INR-P-810/VIII/C) Available from Nucl. Energy Inform. Center, Warsaw

The influence of temperature on the cation exchange reaction of traces of alkali metals on sulfonic and phenolsulfonic resins was investigated. The corresponding thermodynamic functions were calculated. The existence of coordination bond between Cs^+ ion and the hydroxyl groups of phenolsulfonic resin was established. Author

N67-39424# Fulmer Research Inst., Ltd., Stoke Poges (England).
HEATS OF FORMATION OF THE FLUOBORATES OF LITHIUM, SODIUM AND POTASSIUM
P. Gross, C. Hayman, and H. A. Joel 3 May 1967 22 p refs
(Contract AF 61(052)-883)
(R.163/SR.3; AFOSR-67-1985; SR-3; AD-657786)

Heats of formation of LiBF4(c) and NaBF4(c) from the constituent fluorides, solid alkali fluoride and boron trifluoride gas, at 110C were measured directly. The heat of formation of KBF4(c) from the constituent fluorides at 25C, based on that of NaBF4(c), was determined by comparing the heats of solution in hydrofluoric acid of the pair, NaBF4(c) + KF(c), with that of the pair KBF4(c) + NaF(c). The following values were obtained: -21.40 plus or minus 0.09 kcal/mole for LiBF4; -32.04 plus or minus 0.12 kcal/mole for NaBF4; -43.13 plus or minus 0.22 kcal/mole for KBF4. With the known values of the heats of formation of BF3(gas), LiF(c), NaF(c) and KF(c), one arrives at the heats of formation of the fluoborates: -439.4 plus or minus 0.7 kcal/mole for LiBF4; -440.6 plus or minus 0.5 kcal/mole for NaBF4; -450.2 plus or minus 0.5 kcal/mole for KBF4. TAB

N67-39428 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
ROUTINE CHEMICAL AND RADIOCHEMICAL PURITY CONTROL OF RADIOISOTOPIC PREPARATIONS. I: Cr-51 PREPARATIONS [METODY RUTYNOWEJ KONTROLI CZYSTOSCI CHEMICZNEJ I RADIOCHEMICZNEJ PREPARATOW RADIOIZOTOPOWYCH. I. PREPARATY Cr-51]
Kazimierz Nowak and Antoni Pasternak 1967 17 p refs In POLISH; ENGLISH summary
(INR-811/XIII/C) Available from Nucl. Energy Inform. Center, Warsaw

Details are presented on the procedures for purity control of Cr-51 preparations. The method used for pH and NaCl content determination are characterized. A colorimeter method is used for the total Cr-content. The standard error for a single determination is about 6%. The consumption of the sample for one determination is about 150 microliters. Paper chromatography is used for radiochemical purity control. The quantity of impurities is calculated as a percentage of activity in proportion to the total activity of the strip. Standard error of determination is not higher than 5% and the accuracy of measurements is about 4.5%. Author

N67-39439# Army Materials Research Agency, Watertown, Mass.
ANODIC BEHAVIOR OF TITANIUM AND ITS ALLOYS IN SULFURIC ACID
Milton Levy May 1967 25 p refs
(AMRA-TR-67-16; AD-657557)

The electrochemical behavior of titanium and its alloys was studied in sulfuric acid media. Electronic potentiostatic anodic polarization techniques were employed. The anodic behavior of titanium was related to the parameters of temperature; acid concentration; chloride, iron, and copper additions to the electrolyte; yield strength level; microstructure of the alloy; and the use of passivating inhibitors. Author (TAB)

N67-39441# Naval Ordnance Test Station, China Lake, Calif.
CHARGE-TRANSFER INTERACTIONS OF THE HIGHER VALENCY HALIDES AND OXYHALIDES WITH AROMATIC HYDROCARBONS. BALL-PLANE INTERACTIONS. MEASUREMENTS OF WEAK INTERACTIONS AND LITERATURE REVIEW
P. R. Hammond Jun. 1967 41 p refs
(NOTS-TP-4368; AD-658333)

The following generalizations are examined in a review of the chemical literature: (1) the covalent higher valency halides,

oxyhalides, and oxides of the elements are molecules of high electron affinity, and will demonstrate charge-transfer absorptions with aromatic hydrocarbon donors; (2) as such donors produce firm complexes only in close, plane-to-plane combinations, and since the interactions will be mostly of the ball-plane type for acceptor structures higher than and including the tetracoordinate state, all interactions will be very weak or just contact. Some brief experiments to test these views are described. In particular, the disappearance of color in frozen mixtures is a useful criterion of simple eutectic phase diagrams. Methods of measuring weak associations are discussed, and the spectral techniques outlined here, namely, equilibria studies in solution, temperature effects on absorption intensity, and color changes in the frozen mixtures, are concluded to be among the most discriminating. Although the evidence is incomplete, the proposals seem to be correct, and the weak interactions are discussed in terms of geometric incompatibility. The positions of the charge-transfer transitions and the relative acceptor strengths are examined in terms of the structures of the molecules. Author (TAB)

N67-39495*# Southwest Research Inst., San Antonio, Tex.
DEVELOPMENT OF BATTERY SEPARATOR MATERIAL PROCESS Interim Report
L. M. Adams, W. W. Harlowe, Jr., and G. C. Lawrason 25 Aug. 1967 66 p Prepared for JPL
(Contracts NAS7-100; JPL-915718)
(NASA-CR-89571) CFSTI: HC $3.00/MF $0.65 CSCL 11I

The preferred procedure for preparing sterilizable battery separator material involves grafing of low-density polyethylene film with acrylic acid, washing of the product with five percent potassium hydroxide, rinsing in water, drying, and crosslinking the dried material with divinylbenzene. The grafting and crosslinking procedure are initiated by irradiation from a cobalt-60 source. Separator material produced by the above procedure and with the grafing carried out in a nitrogen atmosphere at 86°F has an electrical resistance in the range of 6 to 15 milliohm-inch^2 with an average resistance of 10 milliohm-inch^2. Substantial amounts of material prepared by this procedure were shipped to the sponsor. Separator material with a resistance value range of 2 to 6 milliohm-inch^2 and an average value of 4 milliohm-inch^2 has also been prepared suing process modifications. Author

N67-39496# Systems Research Labs., Inc., Dayton, Ohio. Materials Research Group.
RELATIONS BETWEEN POINT DEFECTS IN THE COMPOUND M_2X_6 Interim Scientific Report
N. M. Tallan (ARL), H. C. Graham (ARL), R. W. Vest, and W. C. Tripp Wright-Patterson AFB, Ohio, ARL, May 1967 355 p Prepared jointly with ARL
(Contract AF 33(657)-10815)
(SRL-TR-580-C; ARL-67-0115; AD-658054)

The results of a computer study of the mass action equations as used for the formation of point defects in binary compounds are presented. The results are in easily read tabular form from which a neutrality condition can be deduced for a particular predominant defect. The pressure dependence and the equilibrium constants involved in the formation of each defect are listed. Author (TAB)

N67-39502# Aerospace Corp., El Segundo, Calif. Labs. Div.
ENERGY OF COMBUSTION AND DIFFERENTIAL THERMOGRAMS OF ORGANIC AZIDES, JANUARY 1965–FEBRUARY 1967
Genevieve C. Denault, Paul C. Marx, and Hideyo H. Takimoto May 1967 22 p refs
(Contract AF 04(695)-1001)
(TR-1001(2210-10)-5; SSD-TR-67-128; AD-657768)

The heats of formation of two series of triazoles, 3-azido-s-triazoles, and 4-amino-3-azido-s-triazoles, were determined from the heat of combustion in an oxygen bomb calorimeter. Differential thermograms were obtained to determine the thermal stability of each compound. Of the series of azides studied, the 3-azido-s-triazoles offer greater promise in propellant applications due to their thermal stability and shock insensitivity. Author (TAB)

N67-39565# Naval Research Lab., Washington, D. C. Chemistry Div.
SURFACE EFFECTS IN THE PHOTODEGRADATION OF POLYMER FILMS
Thomas R. Price and Robert B. Fox 5 Jul. 1967 23 p refs
(NRL-6563; AD-657608)

The effect of ultraviolet irradiation in air on the wettability of polymer surfaces by liquids of known surface tensions was studied. The polymers studied were polystyrene, poly(vinyl chloride), poly(ethylene terephthalate), poly(methyl methacrylate), and poly(butyl methacrylate). Changes in contact angles of the contact liquids used were plotted versus the time of irradiation of the polymer surface. Spectral evidence is presented to show that photodegradation products include oxygenated moieties capable of interaction with polar liquids. Polymer fragments resulting from chain scission also play an important role in wettability changes for some polymers. Extraction and spectral studies of irradiated polystyrene surfaces showed that photodegradation products include small molecules, readily removed by extraction, and oxidized (as carbonyl) polymer chains which are not readily removed from the surface. Author (TAB)

N67-39573 Joint Publications Research Service, Washington, D. C.
SOLUBILITY OF URANIUM TETRAFLUORIDE IN ALUMINUM SALT SOLUTIONS
V. M. Vdovenko and G. A. Romanov 19 Oct. 1967 5 p refs Transl. into ENGLISH from Radiokhim. (Leningrad), v. 9, no. 3, 1967 p 384–386
(JPRS-43026; TT-67-33651) CFSTI: $3.00

Data were obtained on the solubility of uranium tetrachloride in $Al(ClO_4)_3$ solutions and the absorption spectra of these solutions. On the basis of these data, $U^{(IV)}$ was found to be in the form of complex $UF^{2+}{}_2$ ions. The solubility of UF_4 was also studied in solution containing hydrated ions of tetravalent uranium. Results show that the complex $UF^{2+}{}_2$ ion forms when UF_2 is dissolved. R.N.A.

N67-39590*# Stanford Research Inst., Menlo Park, Calif.
INVESTIGATION OF REACTIVITY OF LAUNCH VEHICLE MATERIALS WITH LIQUID OXYGEN Annual Report, 1 Jul. 1966–30 Jun. 1967
A. B. Amster, T. Mill, D. L. Chamberlain, R. Stringham, F. Schulenberg et al 31 Aug. 1967 76 p refs
(Contract NAS8-20220)
(NASA-CR-89629; AR-2) CFSTI: HC $3.00/MF $0.65

Continued studies designed to determine the causes of impact sensitivity of launch vehicle organic materials with liquid oxygen are reported. A primary objective is to examine the hypothesis that free radical formation and reactivity are the primary cause of impact ignition. The mechanism of formation of radicals by impact and related processes was studied and attempts were made to establish conditions for ignition of radical-laden samples. On the basis of previous studies which confirmed that grinding of polystyrene produced large quantities of carbon radicals, the similarity between these radicals and impact produced radicals was established. It was further found that these radicals react rapidly and spontaneously with oxygen to produce peroxy radicals; however, the reaction is not sufficiently exothermic nor the products sufficiently unstable

for the reaction to propagate through the substrate. Photographic evidence was found which indicated that hot spot formation, as proposed by Bowden, is required. Reactions of carbon and peroxy free radicals at low temperatures were also studied. Studies of t-butyl peroxy radical reactions using improved techniques were studied. Also studied was the photylses of t-butyl iodide-oxygen and trifluoromethyl iodide-oxygen systems. A structure proof for the azoisobutane photoproduct was completed. Chemical and physical characterizations of samples of fluorosilicone grease are also reported. S.C.W.

N67-39616# Eidgenössische Technische Hochschule, Zürich (Switzerland).

METAL COMPLEXES OF THE 1,3,5 TRIAMINOCYCLOHEXANES AND THE 1,3 DIAMINOCYCLOHEXANES [METALLKOMPLEXE DES 1,3,5 TRIAMINOCYCLOHEXANS UND DES 1,3 DIAMINOCYCLOHEXANS]

Gaudenz Marx (Ph.D. Thesis) 1967 112 p refs In GERMAN
(DISS-3917) CFSTI: HC$3.00/MF$0.65

A method is given for separating the stereoisomers of 1,3,5 triaminocyclohexane based on their differing behavior as complex formers. Balance studies were made of the unstable complexes of cis-cis-triaminocyclohexane and cis-trans-triaminocyclohexane, and the spectra of the resulting nickel and copper complexes are discussed. Condensation with three moles pyridinaldehyde was used to prepare Schiff bases from each of the stereoisomers of 1,3,5 triaminocyclohexane; the bases are sexadentate complex formers. These two ligands, each of which supplies six nitrogen atoms for the coordination, were used to prepare the complexes of Manganese (II), iron (II), cobalt (II), nickel (II), copper (II), zinc, and cadmium. The Schiff base of cis-cis-triaminocyclohexane with three moles pyridinaldehyde was reduced to the cis-cis-tris-(α-pyridyl-methylamino)-cyclohexane, and some complexes were prepared with this sexdentate ligand. Cis-1,3-diaminocyclohexane and its Schiff base were also prepared with two moles pyridinaldehyde for the purpose of comparing it with cis-trans-triaminocyclohexane. A final discussion treats the problem of the dark-colored iron (II) complexes which are obtained with aromatic pyridine and phenanthroline ligands. Transl. by K.W.

N67-39627# Fulmer Research Inst., Ltd., Stoke Poges (England).

HEAT OF FORMATION AND TRANSITION TEMPERATURES OF SOLID LITHIUM HEXAFLUOROALUMINATE

P. Gross, P. D. Greene, and C. Hayman 1 Mar. 1967 13 p refs
(Contract AF 61(052)-447)
(R.163/SR.2; AFOSR-67-1984; SR-2; AD-657785)

A direct calorimetric determination of the heat of the reaction 3LiF(c) + AlF3(c) yields Li3AlF6(c) gave a value of -5.4 plus or minus 0.5 kcal/mole. Five solid forms of Li3AlF6 were identified by high temperature X-ray powder photography and transition temperatures estimated. Author (TAB)

N67-39629# Army Missile Command, Huntsville, Ala. Optical Spectroscopy Branch.

PREPARATIVE SCALE GAS-LIQUID CHROMATOGRAPHY OF SUBSTITUTED DIAZIRINES

James A. Merritt, William N. Knopka, Ronald W. Mitchell, and Lawrence C. Robertson Aug. 1967 12 p refs
(RR-TR-67-13; AD-658988)

The heretofore unseparated reaction mixture resulting from the reaction of acetamidine hydrochloride with sodium hypobromite has been resolved into two pure substances: 3-chloro-3-methyldiazirine and 3-bromo-3-methyldiazirine, using preparative scale gas-liquid chromotography (GLC). The general utility of this method of purification has been extended to a series of substituted diazirines. In all cases, the resultant material was free from either contaminants or decomposition products. Product identification was accomplished by utilizing infrared and ultraviolet spectroscopy and mass spectrometry. Author (TAB)

N67-39639# United States Rubber Co., Wayne, N. J. Research Center.

POLYMERIZATION STUDIES LEADING TO HIGH STRENGTH CHEMICAL RESISTANT ELASTOMERS SERVICEABLE AT TEMPERATURE EXTREMES Semiannual Report, 1 Dec. 1966–31 May 1967

Douglas I. Relyea, Homer P. Smith, and Arnold N. Johnson Jun. 1967 37 p refs
(Contract DA-19-129-AMC-487(N))
(Rept.-68-12-CM; SAR-5; AD-657675)

Rhodium compounds were found to give good conversions of fluorinated dienes to polymers in aqueous emulsion systems. For example, a 51:49 copolymer (Tg -48 deg.) of 1,1,2-trifluorobutadiene and butadiene was prepared in this way in 59% conversion in 17 hours at 50C. Several of the copolymers are formed with monomer ratios approaching the feed ratios. Microstructure of these polymers has been examined in a preliminary way by means of infrared and n. m. r. measurements. Other catalyst and fluorinated-monomer combinations were screened for activity in homopolymerization and copolymerization. A number of fluorinated sulfenyl chloride-modified cis-polybutadienes and one rhodium initiated copolymer were prepared on a scale large enough for preliminary evaluation at the U. S. Army Natick Laboratories. Author (TAB)

N67-39641# RAND Corp., Santa Monica, Calif.

THE NUMERICAL INTEGRATION OF KINETIC EQUATIONS FOR CHEMICAL SYSTEMS HAVING BOTH SLOW AND FAST REACTIONS

R. J. Clasen Sep. 1967 67 p refs
(P-3547; AD-658012)

A method is presented which speeds up the integration of kinetic equations for chemical systems having widely variant reaction rates. An algorithm is given for finding the conservation equations for a chemical system. An example is analyzed in detail using the given techniques. Author (TAB)

N67-39692# Eidgenössische Technische Hochschule, Zürich (Switzerland).

ASSOCIATION OF AMORPHOUS POLYPROPYLENE [ASSOZIATION AMORPHER POLYPROPYLENE]

Hans Georg Dietschi (Ph.D. Thesis) 1966 81 p refs In GERMAN
(DISS-3892) CFSTI: HC$3.00/MF$0.65

Propylene was polymerized with a catalyst of titanium tetrachloride and aluminum triethyl to products of various moelcular weights and stereomery. The products were separated into an ether-soluble fraction, a heptane-soluble fraction, and an insoluble remainder. Poly-cis-1,4-isoprene was hydrated with a nickel/kieselguhr catalyst. The ether-soluble polypropylenes are associated in all solvents that were examined, and it was found that the association increases in bromobenzene with increasing temperature. A method was derived for calculating the balance constants of the association. The free enthalpy of the association process is practically temperature-independent with −4.5 kcal/mole, the entropy change increases at higher temperatures. Thermodynamic data indicate a minimum of nine base units per associating sequence. The increased association tendency with higher temperature is probably caused by conformative changes and an increase in dissolved solution molecules. Transl. by K.W.

N67-39695# Oak Ridge National Lab., Tenn. Chemical Technology Div.

PREPARATION OF LANTHANIDE OXIDE MICROSPHERES BY SOL-GEL METHODS

C. J. Hardy, S. R. Buxton, and M. H. Lloyd Aug. 1967 68 p refs
(Contract W-7405-ENG-26)
(ORNL-4000) CFSTI: HC $3.00/MF $0.65

Lanthanide oxide microspheres have been produced with a controlled size in the diameter range 50 to 500 μ, a density of up to 98% of the theoretical crystal density, a low surface area (0.01 to 0.1 m^2/g), and a high resistance to crushing. Hydroxide sols and gels were used as intermediates. Spectroscopic methods were used to rapidly determine the nitrate and metal ion concentrations in the sols, to study the form of bonding of the components of the sols and gels, and to estimate the sizes of the aggregates of colloidal particles. Electron microscopy and electron diffraction measurements showed that the initial precipitates of lanthanide hydroxides consisted of amorphous particles of 30 to 60 Å in dia. When aged in the mother liquor, these particles changed into crystalline sheets; when thoroughly washed and aged in water, they changed into rods, tubes, or rolled sheets. Electron micrographs of replicas of etched polished surfaces of the dense oxides showed 5- to 10-μ wide grains that contained oriented crystalline units that were 0.2 to 0.5 μ wide. NSA

N67-39699# Atomics International, Canoga Park, Calif.
THE CONSTRUCTION AND OPERATION OF A SODIUM PURIFICATION APPARATUS
R. L. McKisson, R. L. Eichelberger, and J. B. Ott 15 Jul. 1967 45 p refs
(Contract AT(04-3)-701)
(NAA-SR-12444) CFSTI: HC $3.00/MF $0.65

An apparatus for purifying sodium by a process involving hot gettering and distillation through a fractionating column was constructed and operated with success. Gettering was accomplished by the use of zirconium foil at 650°C. The gettered sodium was distilled at 550°C through a packed column equivalent to two theoretical distillation plates. The product sodium has fewer and lower concentrations of metallic impurities than does a 99.999% pure spectroscopic-grade sodium chloride standard. The oxygen content of the sodium product ranges downward from 5 to 0.6 ppM, the latter value having been obtained in the latest preparation. Author (NSA)

N67-39715# Army Weapons Command, Rock Island, Ill. Research and Engineering Div.
SURFACE POTENTIALS OF ADSORBED ORGANIC MONOLAYERS ON METALS Final Technical Report
Peter Martin, Jr. Jul. 1967 22 p refs
(RIA-67-1754; AD-658058)

Surface potential measurements were accomplished to determine the effects of adsorbed organic monolayers on metal substrates. This data was used to characterize the monolayers as to their orientation, packing and polarization on metals. The vibrating condenser method was used to make surface potential measurements. The method is based on the principle of changing the capacity of a condenser formed by a reference electrode (Pt) and the metal to be studied. Any changes occurring on the metal will be detected by a potential change. Results obtained in this study were that (a) monolayers of acids, alcohols and amines absorbed on chrome cause an increase in the surface potential with an increase in carbon chain length; (b) oil solutions containing additives gave surface potentials in the order: octadecylamine > stearamide > stearic acid > octadecanol, and (c) temperature of wetting curves for the amines and amides correlated with surface potential curves. Conclusions derived were that (a) when alcohols, acids and amines of a sufficient chain length are adsorbed on chrome they form a close-packed oriented monolayer; (b) the tendency of adsorption from an oil solution onto steel depends on the type of additive used; and (c) amides with carbon chain lengths less than 16 have a higher energy of adsorption than the corresponding amines. Author (TAB)

N67-39727# Johnston (W. H.) Labs., Inc., Baltimore, Md.
FUNDAMENTAL STUDIES RELATING TO THE RADIATION CHEMISTRY OF SMALL ORGANIC MOLECULES Final Report, 15 Aug. 1962–15 Dec. 1966
Marvin Vestal and Gerald Lerner Wright-Patterson AFB, Ohio, ARL, Jan. 1967 145 p refs
(Contract AF 33(657)-10846)
(ARL-67-0114; AD-658864)

The report describes methods for performing calculations on the unimolecular reactions of excited polyatomic molecule ions. The theoretical basis for the calculations is presented. The complete FORTRAN program developed for performing these calculations is given together with flow charts and detailed descriptions for the program. The complete input data deck for propane is given and some examples of the results are included. Author (TAB)

N67-39739# RAND Corp., Santa Monica, Calif.
THERMOCHEMICAL RELATIONS FOR WATER AT HIGH TEMPERATURES AND PRESSURES
R. A. Papetti and M. C. Fujisaki Aug. 1967 55 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-4969-PR; AD-658821)

A compilation is given of the equations and data necessary to determine the equations of state and equilibrium composition of a dense mixture of chemically reacting gases. Emphasis is on the thermodynamic regions that could be attained by this mixture upon subjecting water to a nuclear burst. At present, there are no adequate experimental data to explain the thermodynamic equilibrium properties of water at very high pressure and temperature, and no reliable methods exist to determine the correct functional forms for mixtures of polar and nonpolar molecules, ions, and free radicals at close separations and high temperatures. Using the approach of chemical thermodynamics, the study presents methods for determining the pressure, internal energy, entropy, Helmholz free energy, chemical potential, and composition as functions of the temperature and volume of the gas mixture. These should be regarded as interpolation procedures that smoothly join results in other regions that are covered by experimental data or adequate physical theories. Author (TAB)

N67-39751# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
SOLVENT EXTRACTION PURIFICATION OF URANIUM-233 WITH DI-SEC-BUTYL PHENYLPHOSPHONATE
J. F. Phillips, Jr. Jun. 1967 11 p refs
(Contract AT(45-1)-1830)
(BNWL-440) CFSTI: HC $3.00/MF $0.65

A solvent extraction process for separating uranium from thorium, plutonium, polonium, iron, and cobalt has been developed. The extractant is di-sec-butyl phenylphosphonate dissolved in carbon tetrachloride. A flowsheet for the process is given. Author (NSA)

N67-39833*# Brigham Young Univ., Provo, Utah. Dept. of Chemistry.
STUDIES OF REACTION GEOMETRY IN OXIDATION AND REDUCTION OF THE ALKALINE SILVER ELECTRODE Quarterly Report
E. A. Butler and A. U. Blackham 15 Aug. 1967 17 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951911)
(NASA-CR-89556; QR-1) CFSTI: HC $3.00/MF $0.65 CSCL 07D

Preliminary studies of the relationship of current density, conductivity, and temperature to the current and potential distribution around electrodes were made. Polarization curves were established for a silver anode in an ammoniacal electrolyte. A

control sintered electrode made from silver powder of known particle and shape was prepared for testing to determine the effective electrolytic surface area of the electrode in alkaline solution. From the size, shape, and weight of powder used in a given electrode, the total surface area of the powder can be calculated. Other methods found in the literature to determine the electrolytic surface area were also examined. Apparatus is being set up to investigate the effects of ultrasonic vibrations on the oxidation of a smooth silver electrode by studying the current density, charging capacity, electrolyte depletion, and surface smoothing. L.S.

N67-39849# Bureau of Mines, Tuscaloosa, Ala.
HIGH-TEMPERATURE HEAT CONTENTS AND ENTROPIES OF SODIUM BROMIDE AND SODIUM IODIDE
T. Estelle Gardner and A. R. Taylor, Jr. Oct. 1967 11 p refs
(BM-R1-7040)

Enthalpy measurements were conducted on sodium bromide and sodium iodide in the temperature range 400° to 1,200°K using an ice calorimeter. Equations representing enthalpy as a function of temperature were derived from the data by the method of least squares. These equations were used to calculate smooth values of heat capacity, enthalpy, and entropy at 50°K intervals from the ice point to 1,200°K. The melting point determined for sodium bromide was 1,020°K; the melting point of sodium iodide was 934°K. The heats of fusion of sodium bromide and sodium iodide were calculated to be 6,270 and 5,680 cal/mole, respectively. Author

N67-39850# Bureau of Mines, Reno, Nev.
REACTION RATE OF TITANIUM–IRON ALLOYS AND TITANIUM TRICHLORIDE IN MOLTEN SODIUM CHLORIDE
E. K. Kleespies and T. A. Henrie Oct. 1967 14 p refs
(BM-R1-7039)

The kinetics of the reaction of titanium–iron alloys with titanium trichloride dissolved in sodium chloride were determined. The rate of the heterogeneous reaction was determined between titanium–iron alloys and titanium trichloride. The rates of the reactions were about 1×10^{-5} g Ti/cm^2-sec, and the reaction was phase-boundary controlled. Titanium alloys of the body-centered cubic beta structure reacted faster than those with the hexagonal close-packed alpha structure. The intermetallic compound, TiFe, reacted very slowly, whereas $TiFe_2$ was inert. Alloys containing above 89 atomic percent iron gained weight by reacting with titanium species in the salt solution and depositing titanium in the alloy. The effect of $TiCl_3$ concentration on the reaction rate was determined from 2 to 12 weight-percent $TiCl_3$ and at various alloy compositions. At high iron contents, above 50 atomic percent, the $TiCl_3$ concentration effect was small. At lower iron contents, the $TiCl_3$ concentration effect was greater for beta-crystalline alloys than for alpha-crystalline alloys. The temperature dependence of the reaction between titanium alloy containing 8.7 atomic percent iron and titanium trichloride was measured over the temperature range 1,062° to 1,220°K. Author

N67-39855# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
PRECISE DETERMINATION OF OXYGEN IN REFRACTORY OXIDES BY INVERT GAS FUSION—GAS CHROMATOGRAPHY
P. E. Doherty Jul. 1967 11 p refs
(Contract AT(07-2)-1)
(DP-1115) CFSTI: HC $3.00/MF $0.65

A commercial instrument employing inert gas fusion-gas chromatography has been modified to quantitatively determine the oxygen content of actinide oxides and other refractory oxides. The instrument gives a relative precision of 0.4% for samples containing 0.5 to 7.0 mg of oxygen. The method requires 12 minutes per determination, permits flexibility in the choice of sample size, and requires only a single daily analysis to ensure that the calibration curve is satisfactory. Author (NSA)

N67-39905# Los Alamos Scientific Lab., N. Mex.
THE SPECTROPHOTOMETRIC MEASUREMENT OF RHENIUM IN PLUTONIUM–RHENIUM ALLOYS
J. W. Dahlby and G. R. Waterbury 31 Jul. 1967 10 p refs
(Contract W-7405-ENG-36)
(LA-3711) CFSTI: HC $3.00/MF $0.65

Microgram quantities of rhenium in 100-mg samples of plutonium–rhenium alloys were measured spectrophotometrically as the furil dioxime complex following separation from plutonium by a double-distillation from sulfuric–hydrochloric acid solution. Furil dioxime, acetone, and stannous chloride are added to the distillate to form the colored complex, and the absorbance is measured at a wavelength of 532 mμ. The measured molar absorptivity of the complex is 40,100. Based upon a total of 42 determinations of 13.4, 134.4, and 201.6 μg (134 ppM, 0.1344%, and 0.2016%) of rhenium in 100-mg samples, relative standard deviations of 1.4, 0.34, and 0.47%, respectively, were obtained. The method was applied successfully to measurement of rhenium concentrations as high as 8%. Of 35 ions investigated, Cu^{2+}, Ga^{3+}, Hg^{2+}, Mo^{6+}, NO_3^{9-}, Pd^{2+}, Pt^{4+}, Ru^{2+}, Sb^{3+}, and Ta^{5+} caused an interference of greater than 2% when present in 50-mg quantities. Author (NSA)

N67-39910# Rocky Flats Div., Dow Chemical Co., Golden, Colo.
CALCIUM–LEAD ALLOY ANALYSIS BY ATOMIC ABSORPTION AND EMISSION SPECTROSCOPY
Harlan N. Barton, Andrew J. Johnson, and Glenn A. Shepherd 9 Aug. 1967 8 p refs
(Contract AT(29-1)-1106)
(RFP-978) CFSTI: HC $3.00/MF $0.65

Analysis of a calcium–lead alloy by atomic absorption spectrometry and emission spectrography is described. Calcium in the 0.04 to 0.10% range is determined by an atomic absorption method. Samples are dissolved in nitric acid, lanthanum added to eliminate possible interferences, and the samples aspirated into an acetylene air flame. Recoveries on 11 synthetic samples averaged about 100%. The relative standard deviation on 11 aliquots of the same sample was 0.30% on a sample containing 640 ppM of calcium. A semiquantitative emission-spectrographic method is used for determination of 46 impurity elements. The alloy is converted to oxide, diluted with graphite, and excited by a dc arc. Spectra are recorded photographically and visually compared with standard spectra. Author (NSA)

N67-39918 European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center.
FEASIBILITY OF USING A URANIUM HOLLOW CATHODE LAMP AS PRIMARY SOURCE IN ATOMIC ABSORPTION SPECTROSCOPY
G. Rossi and N. Omenetto Brussels, EURATOM, Aug. 1967 12 p refs
(EUR-3558.e)

The extreme complexity of the uranium spectrum makes possible the coincidence of its lines with the analytical resonance lines of the most of the elements. Uranium is excited in a Ni hollow cathode at 500 mA discharge current. The advantages of this multi-line source are stressed. First results are then presented for the elements Cu, Mg, Mn, Fe, Ni, Cr and In. Author

N67-39943# Marine Engineering Lab., Annapolis, Md.
INFRARED AND GAS CHROMATOGRAPHIC STUDIES OF MAGNET-WIRE ENAMELS
M. Greenberg and E. H. Halpern Sep. 1967 28 p refs
(MEL-146/67; AD-658724)

Quantitative methods were developed for measuring performance related characteristics of magnet-wire enamels such as residual-solvent content, degree of conversion upon curing, and

changes in molecular structure with thermal aging. Results of both infrared absorption and gas chromatographic studies of cured and thermal aged polyimide and Formvar resin enamels are reported. Sample preparation techniques are described. Correlations are made with standard performance tests such as weight loss on heating and breakdown voltage. Author (TAB)

N67-39956# National Bureau of Standards, Washington, D. C.
BIBLIOGRAPHY ON FLAME SPECTROSCOPY: ANALYTICAL APPLICATIONS, 1800–1966
R. Mavrodineanu (N. Am. Philips Co., Inc.), comp. 23 Feb. 1967 162 p refs
(NBS-Misc.-Publ.-281) GPO: $2.00

A collection of 5113 references is given of works on flame spectroscopy with emphasis on analytical measurement. The period from 1800 to 1966 is covered. The material is arranged as follows: (1) emission, which includes separate categories in early and fundamental papers, books, theses, reviews, excerpts, instrumentation, and analytical procedures; (2) atomic absorption spectroscopy, including hollow cathodes; and (3) electrical discharges having the aspect of combustion flames, which includes rf discharges, plasma arcs, and arc-and-spark-in-flame. Complete bibliographical information and, whenever possible, the corresponding Chemical Abstract number, are included. K.W.

N67-39992# Union Carbide Corp., Oak Ridge, Tenn. Gaseous Diffusion Plant.
THE TUNGSTEN HEXAFLUORIDE–HYDROGEN FLUORIDE TRIPLE POINT CURVE AND ITS APPLICATION TO A METHOD OF ANALYSIS
W. D. Hedge 17 Aug. 1967 22 p refs
(Contract W-7405-ENG-26)
(K-1699) CFSTI: HC $3.00/MF $0.65

The triple-point curve for the binary system tungsten hexafluoride–hydrogen fluoride was determined over the range of 0.0 to 6.0 mole % hydrogen fluoride. This system is represented by the following equation: mole fraction HF = $(\Delta t)^2 e^{-3.65}$, where Δt is the depression of the triple point of pure tungsten hexafluoride in degrees centrigrade. A method is presented for correcting the deviations resulting from nonideality of the binary system. Extensions of the observed triple-point depressions of different ratios of liquid volume to total volume are represented by the following equation: mole fraction $HF = (\Delta t)^2 \exp(-4.15 + 1.11R - 0.61R^2)$, where Δt is defined above and R is the ratio of liquid volume to total volume. Author (NSA)

N67-40033# Naval Ship Research and Development Center, Washington, D. C.
GOLD–CHLORINE AND GOLD–BROMINE EQUILIBRIA IN MOLTEN ALKALI HALIDES
David E. Icenhower (Ph.D. Thesis) Sep. 1967 102 p refs
(NSRDC-2442; AD-659032)

The reaction of Gold with chlorine or bromine in molten alkali halides was studied over a range of temperatures and halogen partial pressures. Equilibrium concentration of Au(I) and Au(III) were determined by chemical analysis of samples taken at temperatures of 350 to 1050C. The equilibrium constants decreased with increasing temperature. This system is considered for use in removing chlorine and bromine from halogenated hydrocarbons in the atmosphere of a submarine since gold has a much higher affinity for chlorine at 100C than at 500C. The lowest practical temperature of operation is 350C due to freezing of the salt mixture. At this temperature pure silver wool would be much more effective in removing the chlorine and bromine but could not be regenerated in place. Author (TAB)

N67-40106# Rocky Flats Div., Dow Chemical Co., Golden, Colo.
LOW ENERGY X-RAY MEASUREMENTS OF SOME TRANSURANIC ELEMENTS WITH A LITHIUM-DRIFTED SILICON DETECTOR SYSTEM
William H. Tyree 8 Aug. 1967 4 p refs
(Contract AT(29-1)-1106)
(RFP-980) CFSTI: HC $3.00/MF $0.65

A lithium-drifted silicon [Si(Li)] detector system was used to measure the L X-ray photon energies of plutonium 238, plutonium 239, americium 241, and curium 244 with a measurement error of ±50 electron volts. Author (NSA)

N67-40108*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
CHEMICAL IMPURITY DATA ON SELECTED ARTIFICIAL GRAPHITES WITH COMMENTS ON THE CATALYTIC EFFECT OF IMPURITIES ON OXIDATION RATE
Howard G. Maahs and David R. Schryer Washington, NASA, Oct. 1967 28 p refs
(NASA-TN-D-4212) CFSTI: HC $3.00/MF $0.65 CSCL 07B

Forty grades of commercially available, nonpyrolytic, artificial graphite have been analyzed for individual elemental impurities and total ash content. Of the impurities detected, Ca and Fe occur frequently in the highest concentration. Sulfur, Ti, Si, and V also occur frequently in significant concentrations. Other elements are sometimes present, but usually in small concentrations or in only a few grades. For most grades investigated, ash content is approximately proportional to the total concentration of impurities. Catalytic effects of various elemental impurities on the oxidation rate of carbon and graphite are determined. Most elements are reported to accelerate oxidation, while only a limited number are reported to inhibit oxidation. The distribution of impurities of each type (i.e., accelerators or inhibitors) and degree of catalytic activity is similar among the 40 grades of graphite analyzed, with only a few exceptions. Since ash content for most grades is roughly proportional to total impurity content, ash content should, in general, be a convenient and approximate measure of the degree of catalytic acceleration. However, since atypical distributions of impurities occur in a few cases, concentrations of the strong accelerators and inhibitors should always be determined in addition to ash content. Because the combined effect of the impurities occurring in most graphites is catalytic acceleration, it is obvious that in order to minimize acceleration of the inherent oxidation rate of a graphite, impurities should be reduced to, or maintained at, as low a concentration as possible. A few substances, particularly P and various compounds of P, offer promising possibilities as additives to inhibit oxidation. Author

N67-40118 Royal Aircraft Establishment, Farnborough (England).
THE EQUILIBRIUM POLYMERISATION OF CYCLIC FORMALS [RAVNOVESNAYA POLIMERIZATSIYA FORMALEI TSIKLICHESKIKH]
A. A. Strepikheev and A. V. Volokhina Jul. 1967 10 p refs
Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 99, no. 3, 1964 p 407–410
(RAE-LIB-TRANS-1241)

The polymerisation of the cyclic formals, $CH_2OCH_2(CH_2)_nCH_2$ ($n = 1–5$), tetramethylenebenzal, 4-methyl-1,3-dioxane, and cyclic pentamethyleneformal dimer with camphorsulphonic acid as catalyst was investigated. The stability of the cyclic formals decrease with increasing number of atoms in the ring. Increasing temperature and increasing dilution shift the monomer–polymer equilibrium towards the monomer. The weight proportion of monomer to polymer at equilibrium is independent of the molecular weight of the polymer. Author

N67-40120*# Scientific Translation Service, La Canada, Calif.
EFFECT OF VIBRATION ON CARBOHYDRATE METABOLISM [WPLYW WIBRACJU NA PRZEMIANE WEGLOWODANOWA]
A. Tarnawski Washington, NASA, Oct. 1967 6 p refs Transl. into ENGLISH from Patol. Polska (Warsaw), v. 17, no. 4, 1966 p 565–569
(Contract NASw-1496)
(NASA-TT-F-11324) CFSTI: HC $3.00/MF $0.65 CSCL 06C

In white rats subjected to vibration, blood sugar levels, blood sugar curves with and without glucose loading, adrenalin and insulin tests, blood levels of lactic acid and glycogen content of the liver and skeletal muscles were determined. These indexes of carbohydrate metabolism revealed distinct deviations from normal: lowered blood sugar levels, lower blood sugar curves after vibration, diminished hyperglycemic action of adrenalin, longer periods of hypoglycemia after insulin, raised levels of lactic acid, and depletion of the glycogen stores in the liver and muscles. Author

N67-40125# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
CHEMICAL SAFETY FOR TECHNETIUM-99 RECOVERY BY ANION EXCHANGE Final Report
W. J. Van Slyke Jan. 1967 45 p refs
(Contract AT(45-1)-1830)
(BNWL-476) CFSTI: HC $3.00/MF $0.65

The chemical self heating hazards for a proposed technetium-99 recovery process were thoroughly analyzed experimentally and by digital computer simulation. The important factors found were reaction kinetics and stoichiometry, flow rate, and system dimensions. Process thermal behavior is presented graphically for each ion exchange material examined, and the possible process hazards and their prevention are discussed. Author

N67-40170# Aerospace Corp., El Segundo, Calif. Labs. Div.
TRIFLUOROMETHYLFLUOROFORMATE, NOVEMBER–DECEMBER 1966
Timothy H. Johnston, Julian Heicklen, and Wayne K. Stuckey May 1967 13 p refs
(Contract AF 04(695)-1001)
(TR-1001(2250-40)-9; SSD-TR-67-38; AD-658848)

Trifluoromethyl fluoroformate was prepared and isolated. Its infrared and mass spectra are recorded. Author (TAB)

N67-40197* National Aeronautics and Space Administration, Washington, D. C.
THERMIONIC EMISSION FROM SILICATE AND ALUMINOSILICATE ION EXCHANGERS [O TERMOIONNOY EMISSII SILIKATNYKH I ALYUMOSILIKATNYKH IONOOBEMENNIKOV]
G. M. Panchenkov, P. A. Akishin, and N. N. Vasil'yev Nov. 1967 6 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 104, no. 4, 1955 p 571–574
(NASA-TT-F-11367) CSCL 07D

Aluminosilicate mixes of the series $Al_2O_3 \cdot nSiO_2$ were prepared by calcination, then impregnated with a solution of LiCl. The samples were heated by a Ta coil, and the thermic emission current of singly charged Li^+ ions was recorded by a mass spectrograph. The intensity of the ionic current shows a typical although weak emission with a slight decrease with time. Similar to the conditions of the activity of Al silicate catalysts there is an optimum of the thermal emission for the compound. Other element ions besides Li^+ can be emitted from aluminosilicates prepared under optimum conditions for mass-spectrometric purposes, e.g., in isotope analysis. By barying the pH of the salt solutions impregnated in the aluminosilicates, it is possible to introduce different ions into the exchanger. Author

N67-40209# Idaho Univ., Moscow.
NEW HYPOFLUORITES CONTAINING NITROGEN Annual Report
Jeanne M. Shreeve 1 Oct. 1967 61 p refs
(Contract Nonr-4217(00); ARPA Order 442)
(AR-4; AD-658735)

Contents: Addition to the carbon-nitrogen double bond of fluorosulfuryl isocyanate, FSO2NCO; Derivatives of bis(trifluoromethyl) ketene which contain fluorosulfato, difluoroimino, and/or fluoroxy groups; Some chemistry of difluoraminocarbonyl fluoride, NF2CFO; The preparation of perfluoroures, (NF2)2CO, and difluoroaminocarbonyl chloride NF2C(O)Cl; New preparations for NF2OCF3 and NF2Cl; A simple method for the preparation of nitrosyl fluoride; The silver (II) fluoride-catalyzed formation of tris(trifluoromethyl)hydroxylamine, (CF3)2NOCF3. TAB

N67-40244# Western Ontario Univ., London. Dept. of Chemistry.
IRRADIATION OF KCl CRYSTALS CONTAINING KSH
Owen E. Facey and Patrick W. M. Jacobs Sep. 1967 5 p refs
(Contract N00014-68-C-0142)
(AD-657604)

When crystals of KCl containing KSH are irradiated with X-rays at room temperature a prominent U-band develops, thus confirming the reaction SH(-) to H(-) + S-i where H(-) denotes a hydride ion on a normal lattice site and S-i an interstitial S atom. Photolysis with u.v. light at 10K results in the above reaction and also in the reaction SH(-) to H-i + S(-). Thus excited SH(-)* ions can break up in either of two ways, neither of which requires much thermal energy. Author (TAB)

N67-40252# Eidgenossische Technische Hochschule, Zurich (Switzerland).
THE INFLUENCE OF PHOTOCHEMICAL CONVERSION OF SATURATED KETONES BY α-SUBSTITUTION [DIE BEEINFUSSUNG DER PHOTOCHEMISCHEN UMSETZUNG VON GESAETTIGTEN KETONEN DURCH α-SUBSTITUENTEN]
Gerhard Hueppi (Ph.D. Thesis) 1967 61 p refs In GERMAN
(DISS-3893) CFSTI: HC $3.00/MF $0.65

The photochemistry of α-hydroxy and α-acetoxy ketones was examined and compared with that of α-sulfonoxy ketones. In solution, these two groups were marked by a strong specificity in the choice of photolytic primary reactions leading to products. Thus, the representatives of the first group yielded almost exclusively products resulting from an α-splitting (→b), while from the corresponding derivatives of the second group under identical conditions for reaction the α-sulfonoxy substituents are eliminated (→c). Transl. by K.W.

N67-40257# Rochester Univ., N. Y. Dept. of Chemistry.
LIFETIME OF FLUORESCENCE FROM THE LOWEST ELECTRONIC STATE IN SULFUR DIOXIDE VAPOR
Robert Brent Caton (Ph.D. Thesis) 1 Oct. 1967 111 p refs
(Contract Nonr-688(15))
(TR-4; AD-658520)

The principal accomplishment of the research was the direct experimental measurement of the radiative lifetime of the (3)B1 state of SO2. The value of this quantity is 0.0067 plus or minus 0.001 sec. TAB

N67-40260# Boeing Scientific Research Labs., Seattle, Wash. Geo-Astrophysics Lab.
ENERGETIC POSITIVE IONS FROM PHOTOIONIZATION OF GASES
P. H. Doolittle and R. I. Schoen Jun. 1967 49 p refs
(D1-82-0542; AD-658788)

The use of photoionization experiments with ion-retarding potentials is discussed. Preliminary results are presented of measurements obtained with O2 and N2O. If O2 is assumed to dissociate directly, it is estimated that a dissociative state exists which at the equilibrium internuclear separation of the ground state of the neutral molecule lies 20.5 eV above the ground state of the neutral. Author (TAB)

N67-40281* Heat Technology Lab., Inc., Huntsville, Ala.
NUMERICAL METHODS OF SOLUTION OF CHEMICAL KINETICS EQUATIONS Final Report
29 Sep. 1967 38 p refs
(Contract NAS8-11850)
(NASA-CR-89657; HTL-TR-40) CSCL 07D

The explicit, implicit, and subdomain methods of integration of the chemical kinetic equations are reviewed. A comparative analysis is made of their utility in the solution of the reacting gas equations in such practical cases as rocket nozzle and plume flows where finite reacting gases are present. Author

N67-40282 Cekmece Nuclear Research Center, Istanbul (Turkey).
DETERMINATION OF THALLIUM BY ACTIVATION ANALYSIS BASED ON THE REACTION $^{203}Tl(n,2n)^{202}Tl$
M. Talat-Erben and Sevim Okar Sep. 1966 16 p refs
(CNAEM-39)

An activation analysis based on the reaction $^{203}Tl(n,2n)^{202}Tl$ is discussed. The product isotope ^{202}Tl has a convenient half-life of 12 days and is a gamma emitter, thereby making the determination specific. On the other hand, owing to the rather high threshold (8–9 MeV) for this reaction and sensitivity is only about 20 μg of thallium for samples irradiated for 30 hours in the close-vicinity of the reactor fuel in a total flux of 10^{13} n/cm^2/sec. Author

N67-40300*# Tyco Labs., Inc., Waltham, Mass.
DEVELOPMENT OF CATHODIC ELECTROCATALYSTS FOR USE IN LOW TEMPERATURE H_2/O_2 FUEL CELLS WITH AN ALKALINE ELECTROLYTE Quarterly Report, 1 Jul. 1966–30 Jun. 1967
J. Giner, J. Parry, L. Swette, and R. Cattabriga 30 Jun. 1967 201 p refs
(Contract NASw-1233)
(NASA-CR-89748; QR-8) CFSTI: HC $3.00/MF $0.65 CSCL 07B

Continued research directed towards the development of an improved oxygen electrode for use in alkaline H_2/O_2 fuel cells is reported. A survey was made on the intrinsic activity of the transition metals; selected transition metal alloys and intermetallic compounds; and transition metal carbides, nitrides, borides and silicides for the electrochemical reduction of oxygen. A more detailed study was made of materials shown to be of interest in the initial survey. These included gold alloys of the precious metals, intermetallic compounds of gold and titanium, nonstoichiometric TiO_2, silver magnesium alloys, Os and Pt/Os alloys, silicon carbide, and barium tantalate. Measurements made on finely divided interstitial compounds of group VIII metals are also described. S.C.W.

N67-40302# Bureau of Mines, Reno, Nev. Metallurgy Research Center.
HEATS OF FORMATION OF HOLMIUM AND TERBIUM TRICHLORIDES
John M. Stuve Nov. 1967 12 p refs
(BM-RI-7046)

The standard heats of formation (ΔH_f°) of holmium trichloride and terbium trichloride were measured by solution calorimetry. Heats of solution of holmium and terbium metals and their anhydrous chlorides were measured in 4.360 molal HCl at 298.15°K. From these measurements ΔH_f° for $HoCl_3$ (c) was calculated as $-240,290 \pm 1,700$ cal/mole, and ΔH_f° for $TbCl_3$ (c) was calculated as $-238,330 \pm 1,500$ cal/mole at 298.15°K. Author

N67-40316 Cekmece Nuclear Research Center, Istanbul (Turkey).
REDETERMINATION OF THE CRYSTAL STRUCTURE OF SODIUM THIOSULPHATE PENTAHYDRATE BY NEUTRONS
Ali Fuat Cesur Mar. 1967 54 p refs
(CNAEM-44)

Neutron diffraction data for okl and hko reflection planes have been collected at the reactor using a M.A.N. spectrometer. A geometrical method has been followed in bringing the crystal into reflecting position. Two projections in the directions [100] and [001], of the structure have been studied by trial-and-error method and the position of all hydrogens have been fixed. Given coordinates for Na, S, and O atoms by Taylor and Beevers and that of hydrogens were refined by difference synthesis. Calculations were carried out on the IBM electronic computer. Two programs—one for coordinates and scattering densities at the center of the atomic peaks and one for molecular geometry and estimated standard deviations in the coordinates and bonds—were developed for IBM-1620 computer. The tetrahedral arrangement of atoms around one of the sulphur atoms were studied and three equal bond lengths were obtained. The shape and arrangement of water molecules and the probable arrangement of hydrogen-bonds have been deduced. Author

N67-40348 Royal Aircraft Establishment, Farnborough (England).
STUDIES ON KINETICS AND THE MECHANISM OF THE OXIDATION OF HYDROCARBONS IN THE GAS PHASE. PART V: THE QUALITATIVE GAS CHROMATOGRAPHIC ANALYSIS OF THE INTERMEDIATE PRODUCTS OF THE OXIDATION OF n-HEPTANE IN THE LOW TEMPERATURE REGION [STUDIUM DER KINETIK UND DES MECHANISMUS DER OXYDATION VON BENZINKOHLENWASSERSTOFFEN IN DER GASPHASE. V. MITTEILUNG. DIE QUALITATIVE GASCHROMATOGRAPHISCHE ANALYSE DER ZWISCHENPRODUKTE DER OXYDATION DES n-HEPTANS IM TIEFTEMPERATURGEBIET]
E. Schroder, G. Ohlmann, and E. Leibnitz Jun. 1967 37 p refs Transl. into ENGLISH from Z. Physik. Chem. (Frankfurt), v. 225, 1964 p 175–196
(RAE-Lib.-Trans.-1234)

The intermediate products of the slow oxidation and cool flame oxidation of n-heptane have been investigated by gas chromatography. About fifty individual compounds were identified and the mechanism of their formation discussed. Author

N67-40351# Temple Univ. Research Inst., Philadelphia, Pa.
HIGH TEMPERATURE INORGANIC CHEMISTRY Annual Progress Report, 31 Jul. 1966–31 Jul. 1967
A. V. Grosse and J. A. Cahill 31 Jul. 1967 30 p refs
(Contract AT(30-1)-2082)
(RITU-1967-16; NYO-2082-12; APR-9) CFSTI: HC $3.00/MF $0.65

Research progress is reported on: general physical and chemical relationships; electric conductivity of liquid Sn, Pb, and Bi; density of U–Be alloys; surface tension of liquid uranium and thorium tetrafluorides; behavior of solid and liquid gallium on mercury at room temperature; mercury wires; centrifugal plasma jet furnace; and interaction of W with Ag and Cu. NSA

N67-40354# Heidelberg Univ. (West Germany). First Dept. of Inorganic Chemistry.
PHOSPHORUS–NITROGEN COMPOUNDS

Margot Becke-Goehring [1963] 12 p refs
(Contract AF 61(052)-682)
(SR-1; AD-658195)

The phosphorus nitride salts $[(C_6H_5)_2\ P(Cl) = N-PCl_3]P\ Cl_6$ and $[(C_6H_5)_2\ P(Cl) = N-PCl_3]\ Cl$ can be prepared by reacting thiophosphinic acid amide with PCl_5. The salts react with SO_2 to form $(C_6H_5)_2P(Cl)=N-P(O)Cl_2$. Author (TAB)

N67-40362# Aerojet-General Corp., Los Angeles, Calif. Center for Research and Education.
HIGH YIELD SYNTHESIS OF THE SMALLER CLOSE-CARBORANES, $C_2B_3H_5$, $C_2B_4H_6$ AND $C_2B_5H_7$
J. F. Ditter 15 Aug. 1967 22 p refs
(Contract Nonr-4381(00))
(TR-13; AD-659044)

Experimental parameters for producing the small closo-carboranes C2B3H5, C2B4H6 and C2B5H7 in nearly quantitative yields from C2B4H8 were obtained. The process involves a short term, relatively high temperature flow system at low pressures. Author (TAB)

N67-40378# General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science.
NEUTRON THERMALIZATION IN DIPHENYL
J. M. Neill, H. Antunez, and D. Sprevak 14 Jun. 1967 15 p refs Presented at the Symp. on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich., 17–21 Jul. 1967
(Contract AT(04-3)-167)
(GA-8050; CONF-670707-5) CFSTI: HC$3.00/MF$0.65

The comparisons of Sprevak's scattering theory for benzene to measurements that have been made of the total cross section of benzene, of the quasi-infinite medium spectrum in benzene and in diphenyl as a function of poison, and of the position dependent thermal neutron spectra at a D_2O-diphenyl interface are described. The results show that the Sprevak model for hydrogen in benzene predicts the cross section and thermal neutron spectra in that moderator reasonably well. However, the Sprevak model for hydrogen in benzene predicts a thermal neutron spectrum in molten diphenyl that is too hard. NSA

N67-40397# Atomic Energy Commission Research Establishment, Lucas Heights (Australia).
LABORATORY DEVELOPMENT OF THE GRIND–LEACH PROCESS FOR THE H.T.G.C.R. FUEL CYCLE. PART 4. LEACHING AND DISSOLUTION OF BERYLLIA BASED FUELS
M. E. Shying, E. J. Lee, and M. S. Farrell Jul. 1967 36 p refs
(AAEC/E180) CFSTI: HC$3.00/MF$0.65

The chemical development of an acid-leach head-end process for the separation of (U, Th)O_2 from a beryllia matrix is described. The work is related to a feasibility study of the high temperature gas cooled reactor fuel cycle. Although more than 99 per cent of the actinides can be recovered in a single batch nitric acid leach, more than 30 per cent of the beryllia is dissolved. When it was found that sulphuric acid selectively dissolved the beryllia, a two-step process using nitric and suphuric acids in sequence was developed, with recycling of the actinide-rich heel to the next batch. Preliminary results from multi-batch experiments indicate that it might be possible to decrease the beryllia loss to the nitrate stream to 10 per cent and still recover 99 per cent of the actinides. Further development of the process would involve the use of proven reactor material irradiated to high burn-up. Suggestions for further research are given. Author

N67-40401# Nuclear Materials and Equipment Corp., Lewiston, N. Y. Niagara Div.
ISOTOPIC ANALYSIS OF BORON BY OPTICAL EMISSION SPECTROSCOPY
E. E. Shuster and F. S. Zabron 28 Jun. 1967 16 p refs
(Contract AT(40-1)-3292)
(NUMEC-3292-5) CFSTI: HC$3.00/MF$0.65

A quantitative spectrochemical procedure for determining the relative abundances of ^{10}B and ^{11}B in boron and its compounds is described. The method is applicable to all isotopic ratios using equipment normally found in or readily available to an industrial spectrochemical laboratory. A solution of the sample is aspirated into a helium-stabilized arc discharge (plasma jet) in which the ^{10}B and ^{11}B emission lines at 3451 Angstroms are excited. The spectra are photographically recorded at high dispersion. From the intensity ratio of the two lines, a relative abundance is determined. Author (NSA)

N67-40461 General Applied Science Labs., Inc., Westbury, N. Y.
COMPARISON OF NUMERICAL METHODS FOR THE INTEGRATION OF THE FINITE-RATE CHEMICAL KINETIC EQUATIONS
H. Schechter and D. E. Magnus 11 Oct. 1967 11 p refs
(TM-161)

Two numerical methods were compared. Stability behavior and its limitation on step size, the order of truncation error, the number of numerical operations, and the ease of implementation were the comparison criteria used. It is concluded that one of the methods is superior for linear systems of ordinary differential equations and also requires fewer operations. E.C.

N67-40472# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
METHOD OF OBTAINING FLUORINATED NITROMETHANES CONTAINING HYDROGEN [SPOSOB POLUCHENIYA FTORIROVANNYKH VODORODSODERZHASHCHIKH NITROMETANOV]
I. V. Martynov, Yu. L. Kruglyak et al 23 Feb. 1967 6 p Transl. into ENGLISH from the Russian Patent no. 159821 (Appl. no. 788021/23-4, 21 Jul. 1962) 1 p
(FTD-HT-66-625; AD-658610)

A method is given for obtaining fluorinated nitromethanes which contain hydrogen (for example, difluonitromethane and fluochloronitromethane) which has the distinguishing feature that a suitable nitro-halide-acetic acid (for example fluochloronitroacetic) is subjected to decarboxylizing by anhydrous potassium fluoride or water. TAB

N67-40479# Rikkyo Univ., Yokosuka (Japan). Inst. for Atomic Energy.
SEPARATION OF RECOILING CHROMIUM (II) SPECIES FROM NEUTRON-IRRADIATED HEXAQUOCHROMIUM (III) ION ADSORBED ON ION-EXCHANGER
Tatsuo Matsura and Takashi Sasaki [1966] 19 p refs
(IAERU-6606)

Since it has been reported that chromous ion is produced as a main recoil product in the neutron-irradiated chromic compound, the dynamic extraction of the ^{51}Cr-enriched chromous species during irradiation of hexaquochromium ion adsorbed on a cation exchange resin was carried out using oxalic acid as the eluent. The dynamic method gave a higher yield and enrichment factor than the static irradiation method. The dynamic irradiation at constant temperature was also performed for the first time and the effects of the irradiation temperature and of bead radius upon the separable yield and the enrichment factor were studied. The enrichment factor increased with decreasing irradiation temperature. The inherent

yield which was estimated from the extrapolation to the zero bead radius increased with increasing irradiation temperature. The results were interpreted by the hypothesis that the thermodynamic equilibrium would be established at the end of the hot reaction in the recoil process. Author (NSA)

N67-40505# United Kingdom Atomic Energy Authority, Harwell (England). Chemistry Div.

RESEARCH ON PLUTONIUM NITRIDE

N. J. Bridger and R. M. Dell Jun. 1967 26 p refs

(AERE-R-5441) CFSTI: HC $3.00/MF $0.65

Plutonium nitride has been prepared as a pure stoichiometric compound by reacting plutonium metal with nitrogen in the presence of hydrogen. The nitride crystallizes in the rock-salt system with a lattice parameter ranging from 4.9033Å for oxygen-free PuN to about 4.908Å for oxygen-saturated PuN. Excess oxygen is present as PuO_2 at low temperatures, but above ≈1000°C this reacts with PuN to yield hexagonal Pu_2O_3: $PuN + 3PuO_2 \rightarrow 2Pu_2O_3 + 1/2N_2$. When heated in oxygen, PuN oxidizes above 200°C at a rate similar to that of UN. Ignition occurs around 280°C, depending upon the particle size. The presence of water vapor facilitates oxidation and ignition takes place in wet oxygen at a temperature as low as 90°C. Mixed nitrides of composition $(U_{0.7}Pu_{0.3})N$ have been prepared by hot pressing above 1500°C. These are considerably more resistant than pure PuN to attack by atmospheric moisture. Author

N67-40515# New York Univ., N. Y. Chemistry Dept.

QUANTUM MECHANICAL STUDY OF MOLECULES TRANSITION PROBABILITIES, EINSTEIN A COEFFICIENTS AND OSCILLATOR STRENGTHS OF SOME BAND SYSTEMS OF DIATOMIC MOLECULES

D. C. Jain and R. C. Sahni [1967] 44 p refs

The Franck–Condon factors and r-centroids based on the Rydberg–Klein–Rees potential energy curves, are presented for some band systems of the CO^+, N_2, N_2^+ and RbH molecules. The variation of the electronic transition moment with the internuclear distance, $R_e(r)$, is determined by the r-centroid procedure for the band systems for which the experimental data on the relative intensity distribution is available. The absolute band strengths, Einstein A coefficients and oscillator strengths are obtained for some band systems by employing the expression for the electric dipole transition moment, $R_e(r)$, and the lifetimes of the excited states. The influence of the vibration–rotation interaction on the transition probabilities of the band system of the RbH molecule is studied and it is found that for this and certain other similar band systems, the vibration–rotation interaction must be included in the theoretical interpretation of the results. The importance and possible applications of these results are described. Author

N67-40567 Atomic Weapons Research Establishment, Aldermaston (England).

THE REACTION OF HYDROGEN WITH METAL DEUTERIDES

P. M. S. Jones and R. Gibson Jul. 1967 12 p refs

(AWRE-O-50/67) HMSO: 1s 9d

The exchange and gettering kinetics for the reaction between erbium deuteride films and hydrogen gas show that oxide barriers inhibit exchange and retard but do not stop gettering. Author

07 COMMUNICATIONS

Includes communications equipment and techniques, noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

N67-39443# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

A RECEIVER WITH A SYNCHRONOUS PARAMETRIC AMPLIFIER [PRIYEMNIK S SINKHRONNYM PARAMETRICHESKIM USILITELEM]

V. V. Boyko and Yu. V. Dagayev 21 Feb. 1967 17 p refs Transl. into ENGLISH from Vestn. Mosk. Univ., Ser. III, Fiz., Astron. (Moscow), no. 3, 1965 p 64–72

(FTD-HT-66-275; TT-67-62871; AD-658369)

A receiver with a degenerate parametric input amplifier that operates in a synchronous mode is theoretically and experimentally investigated. Synchronous pumping is obtained by means of a special feedback loop. It is shown that the appropriate frequency selection of the first heterodyne expands the frequency band of the synchronous mode with strong resonance. Author (TAB)

N67-39444# RAND Corp., Santa Monica, Calif.

PRIOR INFORMATION AND BIAS IN SEQUENTIAL ESTIMATION

Allen Klinger Aug. 1967 7 p refs Prepared in cooperation with JPL

(P-3655; AD-657754)

This article applies discrete sequential filtering to estimation of an unknown vector x imbedded in nonstationary uncorrelated noise, when observations depend linearly on x in a time-varying manner. Such a situation occurs in trajectory determination close to the earth. We solve the recursive filter equations to obtain the n-th estimate of x, xn, and its convariance matrix Pn, in terms of the observations (zi, i = 1, ..., n) and initial values xo, Po. These expressions illustrate how the a priori information can introduce bias into the sequential estimates. TAB

N67-39457# RAND Corp., Santa Monica, Calif.

OPTIMUM PROCESSING OF UNEQUALLY SPACED RADAR PULSE TRAINS FOR CLUTTER REJECTION

L. E. Brennan and I. S. Reed Aug. 1967 12 p refs

(P-3657; AD-657755)

Coherent variably spaced pulse trains can be processed using a time domain representation, i.e., describing the signal processor by a set of complex weights applied to the successive pulses rather than by a filter transfer function. The variations in clutter return during the pulse train are expressed in terms of a covariance matrix rather than a frequency spectrum. Using this approach, methods of selecting the optimum set of complex weights for a pulse train are derived. A test based on the likelihood ratio is discussed and an optimum set of complex weights is obtained for detecting targets of known doppler frequency. A more tractable criterion, based on the maximum signal-to-clutter ratio, is developed for selection of the pulse weights. The analogous problem for equally spaced pulse trains has been discussed by Rummler. With equally spaced trains, the design problem is one of selecting an optimum set of complex weights for the pulses and of specifying the interpulse spacing. With variable spacings there is the additional problem of selecting a good interpulse spacing code. No direct method for optimizing the spacing code was found. It is shown that for a particular form of the clutter autocorrelation function, the covariance matrix can be inverted and an analytic expression obtained for system performance as a function of target doppler

frequency. This should be useful in testing different spacing codes so that one can be selected for a particular system application. TAB

N67-39493# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
RADAR CONTINUOUS-WAVE
N. P. Supryaga 5 Apr. 1967 103 p refs Transl. into ENGLISH of the book "Radiolokatisiya s Nepreryvnym Izlucheniyem" Moscow, Voyennoye Izd., 1963 p 1–123
(FTD-MT-65-521; TT-67-62870; AD-658370)

The book deals with characteristic features, main merits and deficiencies of continuous-wave radar systems. Section II treats continuous-wave radio altimeters of the STR-41, AM220 and Selford type. TAB

N67-39494# Air Force Communications Service, Scott AFB, Ill.
OPERATIONS ANALYSIS OF AIR FORCE COMMUNICATIONS SERVICE FIXED GROUND POWER. PART II: NO-BREAK POWER SYSTEMS, OPERATIONAL AND COST ANALYSIS
Gustav E. Wendland Jul. 1967 95 p
(Rept.-3-ORR-67, Pt. II; AD-819554)

This Operations Research Report, 3-ORR-67 Part II, completes the operations analysis of Air Force Communications Service fixed ground power, and provides a detailed analysis of no-break power system designs, configurations, performance and cost effectiveness. This report discusses numerous commercial no-break power systems which are available to satisfy this critical power support requirement. TAB

N67-39511# Harvard Univ., Cambridge, Mass. Engineering and Applied Physics Div.
MEASUREMENT AND PREDICTION OF GROUP VELOCITY AT VERY LOW RADIO FREQUENCIES
J. A. Pierce Jul. 1967 123 p refs
(Contract Nonr-1866(07))
(TR-535; AD-657949)

Sample measurements of times of arrival of Omega signals in the VLF frequency band are reduced to approximate times of propagation and then to the reciprocal of the relative velocity of propagation. A function of the altitude of the sun is then found which, when integrated along the transmission path, yields a synthesis of the transmission time. Two of these functions for two frequencies yield the group transmission time for a difference frequency. It is suggested that this function will make a convenient means for intercomparing data for different paths and different frequencies, in the expectation that corrections can then be made for various factors that have a minor effect upon the speed of propagation. Identification of the importance of these factors should lead to better prediction of the absolute velocity for any path at any time. Author (TAB)

N67-39529# Columbia Univ., Dobbs Ferry, N. Y. Hudson Labs.
RANDOM STORE AND FORWARD COMMUNICATION NETWORKS WITH APPLICATIONS TO PATTERN RECOGNITION
Stephen D. Shapiro (Ph.D. Thesis) Apr. 1967 140 p refs
(Contract Nonr-266(66))
(Rept.-58; AD-658136)

A random network model which may be used to represent various physical processes is described. These processes include signal flow in a teletype network where the lines joining pairs of stations are not always available, in a network where signals may be lost in transmission or at any node, and in a group of people where simultaneous knowledge of a signal (message) by all members is desired. Other processes which take place in store and forward communication networks may be represented formally using the model. Among these are alternate routing procedures, generation of copies to reduce overall delay, transmission from multiple sources to multiple destinations, circulation or looping of messages, and random overall message delay. TAB

N67-39634*# Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.
SUPPLEMENTAL SELECTED STUDIES OF VHF/UHF COMMUNICATIONS FOR PLANETARY (MARS/VENUS) RELAY LINKS Final Report
18 Sep. 1967 103 p refs
(Contract NAS2-3772)
(NASA-CR-73145; AED-R-3210) CFSTI: HC $3.00 CSCL 17B

Continuing research is reported on communications between a probe entering a planetary atmosphere and a nearby spacecraft bus. In the multipath propagation study, the correlation function describing the surface roughness is assumed to be exponential rather than analytic, and therefore the pattern of incoherent scatter is more diffuse. It is suggested that the fading rate in the case of very diffuse scattering would be higher than in the case of directional scattering. Fast Rician fading with and without Doppler offset was investigated, and several ways of improving link performance were found and are discussed. The effects of fast fading, with and without Doppler offset, on the performance of the link with a bit synchronizer were also studied, and no degradation due to the fading was noted. To determine performance criteria, the system was tested over a range of fast fading bandwidths and Doppler offsets for small sample lengths and for error distribution as predicted assuming random independent errors. It was concluded that the errors are independent and random, and that the bit error rate is a valid measure of performance. N.E.N.

N67-39540# Navy Underwater Sound Lab., New London, Conn.
QUASI-STATIC FIELDS OF ELECTRIC DIPOLE ANTENNAS AT THE SURFACE OF AN ANISOTROPIC HALF-SPACE
Peter R. Bannister 3 Aug. 1967 20 p refs
(USL-838; AD-658320)

The electric and magnetic field components produced by vertical and horizontal electric dipoles located at the surface of a semi-infinite anisotropic medium have been derived and presented for the quasi-static range. The receiving antenna has also been assumed to be located at the earths surface. It is shown that when the coefficient of anisotropy is unity, the results reduce to those of the isotropic earth. Some numerical values for the field-component functions have also been provided. Author (TAB)

N67-39545# Rome Air Development Center, Griffiss AFB, N. Y.
AN ADAPTIVE TECHNIQUE FOR MULTIPLE SIGNAL DETECTION AND IDENTIFICATION
John W. Sammon, Jr. Aug. 1967 47 p refs
(RADC-TR-67-260; AD-658015)

The problem of detecting and identifying multiple signals which are corrupted by independent additive noise is mathematically formulated. It is explicitly assumed that (1) the epoch and time duration of the signals are known, (2) the statistics of the corrupting noise are known, (3) the number of signals and their individual shapes are not known, and (4) the a priori probabilities of the occurrence of the individual signals are not known. An adaptive technique is developed to determine (1) the number of signals, (2) the signal shapes, and (3) the relative frequency of each signals occurrence. The adaptive procedure uses only the observations made at the receiver output. Computer simulated results are given for the case of Gaussian noise. These results clearly indicate that approximate detection and identification can be achieved adaptively. Author (TAB)

N67-39567# Leeds Univ. (England). Dept. of Electrical and Electronic Engineering.

WAVE PROPAGATION ALONG PERIODIC STRUCTURES AND PLASMA SLABS Final Scientific Report, 1 Oct. 1964–30 Apr. 1967

Joshua S. L. Wong and Peter J. B. Clarricoats 1 May 1967 52 p refs

(Contract AF 61(052)-783)

(LU/EE/67/05; AFCRL-67-0441; AD-656787)

Guided electromagnetic wave propagation along two distinctly different structures has been studied. Structure A consists of a disc-loaded dielectric rod with or without a centre conductor. The main objective is to evaluate its use as a microwave delay-line for pulse compression. Expressions for the dispersion equations, power flow and attenuation coefficient are derived and numerical results of group-delay, propagation and attenuation coefficient as a function of signal frequency are presented for a range of values of the parameters. The problem of determining a set of parameters which will give rise to a prescribed propagation characteristic, in particular that giving linear group delay vs frequency has been solved numerically using an optimization procedure. Structure B consists of a plasma slab backed by a conducting plane with or without an ion sheath between them. The constraints usually applied to this model of zero loss, zero electron temperature and no ion sheath are relaxed one at a time, and dispersion curves with one or more constraints relaxed are presented. This procedure is deemed necessary to aid interpretation of experiments on laboratory or actual plasmas which are not definable by a single idealized model. The theoretical formulation of the problem is such that extension to more complicated plasma-slab configurations can be readily made. Author (TAB)

N67-39578# Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.

ELECTROMAGNETIC INTERFERENCE MEASUREMENT METHODS-SHIELDED ENCLOSURE Quarterly Report, 1 Dec. 1966–28 Feb. 1967

William R. Free, Charlton H. Bonham, Robert E. Gibson, and Bernard M. Jenkins Aug. 1967 46 p

(Contract DA-28-043-AMC-02381(E))

(A-945-3; ECOM-02381-3; Rept.-35; QR-3; AD-657669)

Investigation of techniques and procedures for making radiated measurements in shielded enclosures, which can be correlated with measurements made in the open-field, have continued. A microwave hooded antenna for use over the 1 to 12 GHz frequency range was evaluated after a modification to integrate a series injection calibration network into the antenna structure. The results of this evaluation indicate that the characteristics of the probe antenna are acceptable. An evaluation of a uhf hooded antenna for use over the 200 to 1500 MHz region was completed. The results of this evaluation indicate that the characteristics of the hooded probe antenna are acceptable, a series of antenna coupling measurements were performed in an 8×8×12 foot shielded enclosure over the frequency range from 1 to 100 MHz. The results from these measurements were compared with results obtained in an 8×8×20 foot enclosure to determine the effects of enclosure dimensions on measurements in this frequency range. A computer program for simulating reflection conditions in a shielded enclosure was completed during this period. The development of the computer program and a discussion of preliminary results obtained with the program are presented. Author (TAB)

N67-39584# Michigan State Univ., East Lansing. Div. of Engineering Research.

MODIFICATION OF BACKSCATTERING OF A LOOP BY IMPEDANCE LOADING

J. L. Lin and K. M. Chen 20 May 1967 201 p refs

(Contract AF 19(628)-5732)

(AFCRL-67-0429; SR-3; AD-657799)

In the report the modification of the backscattering of a loop by the impedance loading method is investigated theoretically and experimentally. First of all, the resonant phenomena of a loop when illuminated by an electromagnetic wave is studied. Next, the backscattering of a circular conducting loop is considered and the impedance loading method is applied to minimize its backscatter. Finally, the minimization of the backscattering of a rectangular loop is investigated. In the theoretical analysis, a new method based on a differential equation for the loop current is developed for the case of a circular loop. For the case of a rectangular loop an existing method is applied with slight modification. Throughout the entire analysis, the principle of superposition is applied to simplify the problem of an illuminated loaded loop to the combination of an illuminated solid loop and a radiating loop. The major objectives of the theoretical analysis are to determine the induced current on a loaded loop, the scattered field from a loaded loop and the optimum impedance which, when loaded on the loop, makes the backscatter of the loop vanish. Extensive experimental study was also conducted. The resonant phenomena of a solid loop was investigated carefully. The impedance loading technique was then applied to the circular and the rectangular loops to minimize their backscatters. In the course of this experiment, the backscatter of a loop was successfully minimized to the noise level. Author (TAB)

N67-39609# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SELF-TUNING SYNCHRONOUS FILTER [SINKHRONNYY SAMONASTRAIVAYUSHCHIYSYA FIL'TR]

Yu. N. Grekhov 24 Feb. 1967 6 p Transl. into ENGLISH from Russian Patent no. 176997 (Appl. no. 906891/26-9, 18 Jun. 1964 2 p

(FTD-HT-66-724; AD-658611)

A self-tuning synchronous filter for selecting signals with respect to shape is introduced. It consists of a multiplier, an adder stage, delay lines, phase shifters, and limiting amplifiers. To separate a weak quasiharmonic signal from strong fluctuating background noise and to simplify the multiplier circuit, the latter is designed in the form of two bridge-balanced transistor modulators. Author (TAB)

N67-39613# Northeastern Univ., Boston, Mass. Communication Theory Group.

OPTIMUM LINEAR INTERPOLATION OF SAMPLED FUNCTIONS

Martin Schetzen Apr. 1967 69 p refs

(Contract F19628-67-C-0112)

(Rept.-7; AFCRL-67-0407; AD-658862)

A study of linear interpolation of sampled random processes is presented in this report. A mathematical model of a sampler and of an interpolator are first developed. These models are used to derive general expressions for the mean-square interpolation error. The specific examples of zero- and first-order interpolation are used to illustrate the expressions. The problem of optimum interpolation is then formulated using the criterion that the mean-square error be a minimum. Explicit expressions for the optimum causal linear filter for interpolation using corrupted samples and expressions for the resulting minimum mean-square error are obtained. These results are illustrated by some specific examples of practical importance. A simple upper bound of the mean-square error is derived and a generalization of the sampling theorem for random functions is obtained by use of this bound. Although the important case of periodic sampling is emphasized in this report, the extension to a periodic sampling is given. Author (TAB)

N67-39634# Harvard Univ., Cambridge, Mass. Engineering and Applied Physics Div.

THEORETICAL STUDY OF DIPOLE ARRAY OF N PARALLEL ELEMENTS

V. W. H. Chang and R. W. P. King May 1967 137 p refs

(Contract AF 19(628)-2406; Grant NSF GK-273)

(AFCRL-67-0404; SR-18; AD-658030)

The five-term method developed for two arbitrarily located parallel antennas has been successfully extended to a general antenna array of N parallel elements. The method is illustrated with a planar array and a three-dimensional array. Arrays of both full-wave and half-wave elements are discussed. The array is characterized either by specifying driving voltages or by specifying input currents. When the array is of half-wave elements, the conventional EMF method which assumes sinusoidal currents is also carried out in detail for comparison. When the array is of full-wave elements, the EMF method is not applicable; however, equal magnitude sinusoidal currents are assumed and carried out. The difference between these two theoretical results is not always negligible even for the case of half-wave elements or field pattern comparison. Author (TAB)

N67-39645*# Stanford Univ., Calif. School of Engineering.

THE SAINT PROJECT: PRELIMINARY DESIGN OF AN INTERNATIONAL SATELLITE COMMUNICATION SYSTEM

Eugene V. Shaparenko, ed. Aug. 1967 336 p refs

(Contract NSR-05-020-151)

(NASA-CR-89627) CFSTI: HC $3.00/MF $0.65 CSCL 17B

An economical system of synchronous orbit satellites capable of handling the predicted world telecommunications needs in the late 1970's is proposed. The system consists of four satellites designed for international telephone and television communication, and four regional satellites covering the United States and Europe. Included are descriptions of both the international and regional satellite systems, on-board communication subsystems, an economic analysis of ground stations, multiple access techniques, and ground communication subsystems. The satellite configuration and structural design, attitude control system orbit analysis and launch vehicles, and primary and secondary power systems are also described. R.N.A.

N67-39651*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

APOLLO-USBS FLYBY TESTS, A PRELIMINARY QUICK LOOK NOISE ANALYSIS

W. D. Kahn Sep. 1966 27 p ref

(NASA-TM-X-55987; X-507-66-464) CFSTI: HC $3.00/MF $0.65 CSCL 17I

A preliminary analysis of Unified S-Band System high speed range rate and X-Y angular data obtained during the aircraft flyby tests at Bermuda (March 15, 1966), Carnarvon (March 25, 1966), and Merritt Island (April 19, 1966), is discussed. In brief, this analysis consists of fitting polynomials (up to fifth degree) in the least squares sense to tracking data over numerous short data acquisition intervals (to minimize effects due to the motion of the aircraft). The resulting standard deviations of fit are used as measures of the noise characteristics associated with each data type analyzed. Author

N67-39656# Columbia Univ., New York. Dept. of Electrical Engineering.

STUDIES OF GUIDED ELECTROMAGNETIC WAVES IN THE PRESENCE OF AXIALLY NONUNIFORM OR RANDOM PERTURBATIONS

Stephen Lawrence Richter Mar. 1967 205 p refs

(Contract AF 19(628)-5832)

(CU-EE-100; AFCRL-67-0298; SR-3; AD-658056)

A perturbation technique to deal with gross nonuniformities in an otherwise axially uniform waveguiding structure is presented and applied to time-harmonic electromagnetic propagation in the presence of not necessarily small perturbations which may have both axial and transverse dependence and may be either deterministic or random. The method, an iterative procedure similar to the Brillouin-Wigner approach for uniform perturbations, circumvents expansions in powers of a perturbation parameter, which is one cause of poor convergence for perturbations not sufficiently small. As in standard analyses, an expansion in normal modes is utilized, but with the inclusion of a nonlinear phase progression term. Several deterministic examples, chosen to indicate the flexibility of the perturbation analysis to cope with a wide class of electromagnetic problems, are presented. Following a demonstration of the convergence, through an example whose exact solution is known, the method is applied to problems involving radiation from axial arrays of parasitic elements perturbing an open traveling wave structure. The technique is next applied to long distance very low frequency propagation in an idealized earth-ionosphere waveguide. The analysis is finally applied to propagation in waveguides containing media with statistically inhomogeneous, random, gross inhomogeneities over a finite axial range. Author (TAB)

N67-39659# Philco-Ford Corp., Blue Bell, Pa. Advanced Technology Center.

ADVANCED ANTENNA TECHNIQUES Final Report, 1 Mar. 1966–28 Feb. 1967

Thomas K. Kashihara, Stephen Czorpita, and Leo. W. Procopio Apr. 1967 141 p refs

(Contract AF 19(628)-5846)

(AFCRL-67-0317; AD-654692)

The effects of superdirective design on antenna gain and angle accuracy have been investigated. Numerical results indicate that modest improvements in directivity are possible with concurrent gain improvements. The characteristics of phase patterns have also been investigated; these patterns have constant amplitude but wide spatial bandwidth and are important for angular dispersion-compression applications. Factors affecting the maximum likelihood estimates of angular parameters have been studied. Both angle and angle-rate measurements are considered for wideband and narrowband cases. Correlation principles for both electronically and mechanically scanned patterns are reviewed and two new pattern processing concepts are described. Author (TAB)

N67-39686*# Scientific Translation Service, La Canada, Calif.

QUANTUM EFFECTS IN INFORMATION TRANSMISSION SYSTEMS [KVANTOVYYE EFFEKTY V SISTEMAKH PEREDACHI INFORMATSII]

I. A. Deryugin and V. N. Kurashov Washington, NASA, Oct. 1967 27 p refs Transl. into ENGLISH from Kvantovaya Elektron. Proc. of the Rep. Seminar on Quantum Electron. (Kiev), 1966 292–319

(Contract NASw-1496)

(NASA-TT-F-476) CFSTI: HC $3.00/MF $0.65 CSCL 09D

The basic assumptions of information theory change radically in the optical and infrared bands for a low level of eigen noise in the communication channel. The general expression for the entropy capacity of narrow-band and wide-band communication systems is obtained, and the requirements for optimum signal characteristics are determined. Author

N67-39714# Lincoln Lab., Mass. Inst. of Tech., Lexington.

SHORT-PULSE SCATTERING BY A HEMISPHERE

Stephen D. Weiner 18 Jul. 1967 55 p refs

(Contract AF 19(628)-5167; ARPA Order 498; Proj. Defender)

(ESD-TR-67-331; TR-436; AD-658838)

The radar scattering by a conducting hemisphere for incidence along the symmetry axis has been determined as a function of frequency, bistatic angle, and polarization. From this frequency domain information, the short-pulse response is constructed using Fourier synthesis. The range resolution thus afforded permits identification of various contributions to the scattering - in particular, that due to edge diffraction. Results obtained from the geometrical theory of diffraction are in qualitative agreement with those obtained here. Author (TAB)

N67-39716# RAND Corp., Santa Monica, Calif.
ON THE SUMS OF INDEPENDENTLY DISTRIBUTED PARETO VARIATES
M. Blum Aug. 1967 45 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5429-PR; AD-658430)

The Memorandum is an extension of certain analytic results obtained in AD-646 366, A Comparison of Average Likelihood and Maximum Likelihood Ratio Tests for Detecting Radar Targets of Unknown Doppler Frequency, L. E. Brennan, I. S. Reed, and W. Sollfrey, December 1966. It is shown that some asymptotic results derived in AD-646 366 are valid over a much broader range than originally indicated, providing a useful analytic tool for investigating more complicated radar detection problems involving signals of unknown frequency. TAB

N67-39726* Neotec Corp., Rockville, Md.
ERECTILE ANTENNA STUDY Final Report, 2 Mar.–15 Sep. 1967
E. W. Radany 17 Oct. 1967 221 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951847)
(NASA-CR-89572; CR-22.7) CSCL 09F

This report summarizes the results of a parametric study of six techniques for erecting large aperture antennas in space. These antennas have applicability to near-earth or interplanetary missions. The data presented in this document allows a determination of weight-wise optimum antenna configurations for each technique, over a range of antenna deployed diameter varying from 9 to 16 feet, and over a range of antenna stowed diameter varying from 54 to 114 inches. The optimum weight antennas were determined subject to requirements on stowed configuration packaging ratio, thermal deflection limits, 1 g ground test deflection limits, stowed and deployed configuration structural natural frequency, ascent loading conditions, and an assumed 2 g mid-course maneuver load in the deployed configuration. Curves of the optimum antenna weight distributions are presented for each erecting technique as a function of the geometric variables. On a comparative basis, these optimum weight curves permit the selection of the lightest erecting technique for an antenna of specified deployed diameter and specified ratio of deployed/stowed diameters. Author

N67-39746# Harvard Univ., Cambridge, Mass. Cruft Lab.
CURRENT DISTRIBUTION AND INPUT ADMITTANCE OF AN ELECTRICALLY THICK TUBULAR ANTENNA DRIVEN BY A VOLTAGE ACROSS A FINITE GAP ON AN INFINITELY LARGE GROUND PLANE
David C. Chang May 1967 37 p refs
(Contract AF 19(628)-2406; Grant NSF GK-273)
(SR-17; AFCRL-67-0377; AD-658455)

A new integral equation for the current distribution of an electrically thick tubular antenna which is driven by a voltage across a finite gap on an infinitely large ground plane is formulated. It is found that, in order to describe the experimental model of an antenna driven by a coaxial-line over a ground plane more correctly, an additional source term is required in the conventional integral equation of Hallens. This term can be expressed explicitly in terms of both the radius of the antenna and the dimension of the gap. A numerical solution of the integral equation has also been obtained by a so-called approximate product-integration technique and the results have been compared with the experimental data. Author (TAB)

N67-39748# RAND Corp., Santa Monica, Calif.
SOME IMPLICATIONS OF NEW COMMUNICATIONS TECHNOLOGIES FOR NATIONAL SECURITY IN THE 1970S
Leland L. Johnson Sep. 1967 25 p refs Presented at the Conf. on Implications of Mil. Technol. in the 1970s, Elsinore, Denmark, 28 Sep.–1 Oct. 1967
(P-3639; AD-658424)

In view of the extraordinarily rapid technological advances taking place, and the numerous promising applications, questions immediately arise about the implications for national security. The potential contribution of satellite technology to the problem of adequate communication in time of international crisis, and its use for command and control in wartime are two specific areas of concern. In addition, a discussion is presented of some broader implications relating to open and closed societies, the centralization and decentralization of decisionmaking functions, the process of bargaining and negotiation, the viability of alliances during crisis and war, and the long-run structuring and restructuring of national interests and alliances. TAB

N67-39774# Radio Corp. of America, Princeton, N. J. RCA Labs.
SYLLABLE CODER COMMUNICATION SYSTEM Final Report, 1 Jun. 1966–31 May 1967
E. S. Rogers, W. H. Jamison, and P. W. Ross 31 May 1967 199 p refs
(Contract DCA-100-66-C-0092)
(AD-658530)

Describes research done to increase the resolving power of a 200 Speech Element Communication System. This system, whose primary purpose is to save channel capacity normally required for voice transmission, reduces the necessary channel capacity approximately 1000:1. This efficient use of a communication channel is achieved by automatically encoding of the speech signal by machine. The research covered the following subjects: Improve recognition of initial voiced consonants; Improve voiced-unvoiced sound detection; Improve intrasyllabic pause detection; Investigate fine structure speech features; Use fine structure analysis to improve recognition of final /th/ and /f/ and initial /t/ and /k/. The report includes a description of several special analyzers built to effect the desired improvement. The improved analyzer has been evaluated with 19,200 voicings of 960 syllables using 14 speakers. The results indicate that 560 syllables can be recognized with 75 percent accuracy for several speakers. Author (TAB)

N67-39791*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
RADIOMETRIC BORESIGHTING BY SEQUENTIAL LOBING
George G. Haroules and Wilfred E. Brown, III Washington, NASA, Oct. 1967 26 p refs
(NASA-TR-R-272) CFSTI: HC $3.00/MF $0.65 CSCL 17I

Analytic expressions for the angular error signals from sequentially lobed antenna beams in a radiometric mode of operation are derived and verified experimentally. The suppression of antenna sidelobe contributions and discrimination against the atmospheric reradiation component are discussed. The results of an experimental observation program are presented in support of the analysis of the sequential lobing technique. Author

N67-39814 Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.
COMPUTER RAY TRACING TECHNIQUES TO DETERMINE THE EFFECT OF IONOSPHERIC TILTS ON MUF's
Alfred F. Barghausan and James W. Finney *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 138–143 refs (See N67-39802 24-20)

The assumption of spherical stratification of the F2 layer is invalid at certain times, particularly near sunrise and sunset, and near the magnetic equator. The effect of ionospheric tilts on radio propagation is described based on the results obtained using a ray tracing program. Examples are shown of the influence of a tilted ionosphere on the maximum usable frequency (MUF), angles of take-off and angles of arrival for a 2000 km path. Calculations were made using realistic models of electron density distributions vs. height above the ground. Depending on the angle and location of the tilt along the great circle path, results indicate that the MUF can be increased or decreased, compared with the MUF for a concentric-layer. The angles of take-off and arrival can differ by as much as 10°. Author

N67-39827 Navy Weather Research Facility, Norfolk, Va.
TELEPLOT
J. W. Nickerson *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 280–284 (See N67-39802 24-20)

The TELEPLOT procedure described constitutes a method by which computer products and other graphical intelligence can readily be made available to ships and small facilities which have only teletypewriter equipment. These data are received in a plotted form directly from the teletypewriter, and are therefore almost immediately usable for briefing purposes. Author

N67-39847# Naval Research Lab., Washington, D. C.
A DIGITAL MAGNETIC TAPE SYSTEM FOR RECORDING RADAR DATA
P. L. Watkins, J. M. Goodman, and A. M. Knopp 24 Jul. 1967 42 p ref
(NRL-6584; AD-658329)

A versatile multichannel medium-speed data system for recording radar data on magnetic tape directly in digital-computer format was designed for use with the Randle Cliff Radar facility at the Naval Research Laboratorys Chespeake Bay Division, and it is currently installed and operating there. Input data to the system can be analog voltages, which are internally digitized, or digital codes. Timing and reference data are internally generated. The system operates with three simultaneous data scanning rates: (a) basic (radar pulse repetition frequency), (b) submultiple, and (c) a multiple of the basic. Both the sequence and the amount of data sampled at each rate is patchboard-controlled. Any basic scan rate from 6 pulses per second to 3 kilo-pulses per second can be generated, depending on the volume of data. Data are recorded as sequential sevenbit characters at constant density, without intermediate storage, over the full range of trigger rates, through the choice of six tape speeds. Selected portions of the data can be monitored by an on-line printer and lamp display, during recording. Further checks can be made during playback of recorded tapes. The system has developed into an unusually successful preoperational monitoring device for itself and for nearly the complete radar system, in addition to being a versatile and dependable recording system. Author (TAB)

N67-39953*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NETWORK PERFORMANCE ANALYSIS FOR THE GEMINI GTA-8 MISSION
13 Jul. 1966 70 p
(NASA-TM-X-55985; X-550-66-235) CFSTI: $3.00 CSCL 09F

Performance data for the Manned Space Flight Network (MSFN) which was acquired during the eighth Gemini mission, GTA-8, are summarized. The purpose of this analysis is to review the network performance and to obtain an overall perspective of the capability and reliance that can be placed on ground instrumentation. Described are participating agencies and their responsibilities; MSFN participation and the total support it provided during the mission; and the premission activities that transpired to bring the MSFN up to the state of readiness necessary to support the mission. Also reviewed are techniques used in the reduction, annotation, reproduction, and shipment of data acquired by the network. S.C.W.

N67-39954*# Collins Radio Co., Cedar Rapids, Iowa.
EFFECTIVE RADIO CROSS-SECTION ANALYSIS FROM EXPERIMENTAL MEASUREMENTS. ECHO I Final Report, 21 Jun. 1965–28 Apr. 1967
28 Apr. 1967 79 p refs
(Contract NAS5-9648)
(NASA-CR-89589; Rept.-523-0759051-001DIM) CFSTI: HC $3.00/MF $0.65 CSCL 09F

This report describes the reduction to satellite effective radio cross section of the reflected radio signal power measurements which were made on the Echo I passive satellite. The data reduced were taken from measurements at 810 MHz and consisted of 24 satellite passes. The cross-section mean and median, density histogram, and distribution function are presented for each pass; and the data reduction techniques are described. Conclusions drawn from these data showed that the averaged mean effective radio cross section for Echo I within the first month after launch was about 3 db below the theoretical cross section of 729.64 square meters (or 28.63 db relative to one square meter). A comparison of Echo I measured at 810 MHz with Echo II measured at 2.3 GHz during their first years of life shows that the Echo I effective radio cross section was 3 db less than theoretical while Echo II was only 1.0 db less than theoretical. The fading range (10 to 90 percent) also differed in the first year life period; typically, 2 to 4 db for Echo 1 and 13 db for Echo II. The gradual trends in fading over the three year period made the Echo I passive satellite appear more similar to Echo II fading. Author

N67-39993* Illinois Univ., Urbana. Dept. of Electrical Engineering.
THE IMPEDANCE OF A SHORT DIPOLE ANTENNA IN A MAGNETOPLASMA
K. G. Balmain 1 Jul. 1964 168 p refs *Its* Aeronomy Rept. 2
(Grants NsG-511; NsG-395; Contract AF 19(604)-5585)
(NASA-CR-89785) CSCL 04A

A formula for the impedance of a short, cylindrical dipole in a magnetoplasma is derived using quasi-static electromagnetic theory. The formula is valid in a lossy plasma and for any dipole orientation with respect to the magnetic field. It is shown that the quasi-static theory can be interpreted in terms of scaled coordinates and that a cylindrical dipole in a magnetoplasma has a free space equivalent with a distorted shape. The dipole impedance is found to have a positive real part under lossless conditions when the quasi-static differential equation is hyperbolic; this indicates that the quasi-static theory predicts a form of radiation. The effects of plasma wave excitation and various assumed current distributions are discussed. Laboratory measurements of monopole impedance are found to agree fairly well with the theoretical calculations. Author

N67-40012# Rome Air Development Center, Griffiss AFB, N. Y.
CROSSCORRELATION OF A MAXIMAL LENGTH BINARY SEQUENCE AND ITS SUBSEQUENCES Final Report

Frederick D. Schmandt, Robert G. McLaughlin, and Jack K. Wolf
Aug. 1967 39 p refs
(RADC-TR-67-261; AD-658839)

One method of synchronizing a communication system uses the cross correlation between a maximal length pseudorandom, binary sequence and a portion of that sequence. Using only part of the sequence causes the correlation function to have peaks when the sequences are not aligned, and thus may cause a threshold decision scheme to synchronize incorrectly. This report describes several methods that compute the histogram of the correlation values for all unique integral bit shifts, using any maximal length sequence and any subsequence length. The report also derives exact analytical results for very short subsequences and for subsequences which are almost as long as the main sequence. The report shows that for any main sequence, if the subsequence length remains constant, the choice of the particular subsequence (within the main sequence) will have little effect on the histogram of the correlation values. Finally the report gives several analogies between the subsequence correlation problem and coding theory.
Author (TAB)

N67-40017# Syracuse Univ. Research Corp., N. Y. Defense Systems Div.
PERFORMANCE OF ELECTRICALLY SMALL BEAMED ARRAY RECEIVING SYSTEMS IN THE PRESENCE OF NOISE Interim Report
Martin Fournier 1 Jun. 1967 87 p refs
(Contract Nonr-4798(00))
(DSD-R-177; AD-658885)

The performance of broadband, electrically small beamed receiving arrays operating in the high frequency band (3 to 30 MHz) and in a random noise environment is studied. The concepts of System Noise Figure (SNF) and Signal-to-Noise ratio Improvement Factor (SNIF) are proposed as criteria for comparing one array antenna receiving system to any reference system when the conditions of operation are defined. Graphical representations of SNIF for the two-element and the four-element antenna systems versus a single element system are presented. The improvement factor (SNIF) is shown to depend on the geometry of the array, on the phasing network and on the ratio of atmospheric noise power to internal system noise power.
Author (TAB)

N67-40019# Navy Electronics Lab., San Diego, Calif.
A HIGH-RANGE-RESOLUTION RADAR Interim Report, Jan. 1966–Jan. 1967
J. H. Maynard, B. F. Summers, and D. R. Wehner 17 Apr. 1967 63 p refs
(NEL-1453; AD-658509)

Basic components have been developed for a radar system with highly versatile wave-form capability. The power amplifier has a 600-Mc/s bandwidth centered at 3.2 Gc/s, prf to 30 kc/s, pulse lengths to 80 microseconds with duty-cycle upper limit of 0.03, and a short-time phase stability of 0.01 second. The first signal form to be implemented with the test model has been completed.
Author (TAB)

N67-40079*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
AN INTEGRATED NASA TRACKING NETWORK FOR APOLLO
J. T. Mengel, F. O. Vonbun, and W. P. Varson 23 Aug. 1962 38 p refs
(NASA-TM-X-55937; X-520-62-134) CFSTI: $3.00 CSCL 17I

A method is proposed for utilizing existing large antenna facilities for the support of the Apollo mission from near earth through the lunar phases and return. The use of a single range and range rate transponder in the Apollo spacecraft using a common RF channel will allow the application of approximately ten geographically dispersed large NASA antenna facilities to this mission, with the resulting redundancy to cover emergency situations and to provide scheduling flexibility—an important consideration in view of the long duration of the Apollo mission. The application of the RF portions of this transponder to the transmission of the PCM-telemetry–voice–television signals and the reception of PCM commands is also considered, thus making the proposed system applicable to all of the Apollo tracking and communications requirements.
Author

N67-40081# European Space Technology Center, Delft (Netherlands).
INSTRUMENTATION. TIMING SYSTEMS [LES MOYENS DE SYNCHRONISATION *EN INSTRUMENTATION SPATIALE*]
J. Labrousse Paris, ESRO, Nov. 1966 18 p In FRENCH; ENGLISH summary Presented at the ESRO Summer School, Oxford, 1964
(ESRO-TM-46) CFSTI: HC $3.00/MF $0.65

The need for some means of timing in conjunction with the tracking data and telemetry signals from a spacecraft is stated. The various methods employed to code the time signals are described, followed by an account of the types of oscillators used (on the ground or in the satellite) to produce these signals. A discussion follows of the phasing of clocks on the ground by means of hourly signals transmitted by certain broadcasting stations and also of the loss of precision of the oscillators due, for example, to aging or temperature variations. When the telemetry signals are received at a ground station, they must be treated before they can be of use; this is done by means of equipment designed either to decode the recorded signals, or to transform them into another code, or to explore a magnetic tape for certain signals specified in advance (tape search system). The report concludes with an enumeration of the timing systems to be found on a launching range, at a tracking station, and at a data processing centre.
Author (ESRO)

N67-40115 Royal Aircraft Establishment, Farnborough (England).
THE INFLUENCE OF EARTH IRREGULARITIES ON RADIO TRANSMISSIONS [DER EINFLUSS VON BODENINHOMOGENITAETEN AUF DIE FUNKBESCHICKUNG]
J. Grosskopf and K. Vogt Jun. 1967 19 p refs Transl. into ENGLISH from NTZ-Nachr. Tech. Z. (Brunswick), no. 8, 1956 p 349–355
(RAE-LIB-TRANS-1227)

An account of a year's work spent in trying to establish a correlation between the bearing errors experienced at a direction finding station and the variation of ground conductivity and contours in the vicinity of the station. The conclusion is reached that although some degree of statistical prediction of likely bearing errors can be made if the ratio of maximum to minimum effective ground conductivity is known, a definite calibration curve cannot in general be calculated because of the complicated variations of effective conductivity found in practice.
Author

N67-40163# Mitre Corp., Bedford, Mass.
ERROR PERFORMANCE OF DIFFERENTIAL PHASE SHIFT TRANSMISSION OVER A TELEPHONE LINE
Julian J. Bussgang and Myron Leiter Bedford, Mass., ESD, Aug. 1967 37 p refs
(Contract AF 19(628)-5165)
(MTP-66; ESD-TR-67-393; AD-658437)

The paper considers differential phase-shift transmission over a band-limited channel with specified phase and amplitude characteristics. The problem treated is the prediction of feasible data rates and corresponding error rates over such channels. An expression is given for the probability of error. This expression takes into account intersymbol and interchannel interference when

differential phase-shift keying modulation is used. A distortion index which is a measure of phase error is defined, and the concept of phase opening which parallels the concept of eye opening commonly employed in the amplitude-shift keying modulation is introduced. This analysis examines effects of various parameters on the performance of a high data-rate transmission system over a telephone line. Results indicate that for a carefully equalized line a single tone system should be used, and that higher order phase alphabets are to be preferred as the bit increases. Author (TAB)

N67-40165# Harvard Univ., Cambridge, Mass. Cruft Lab.
AN EXPERIMENTAL STUDY OF AN ELECTRICALLY THICK, TUBULAR, MONOPOLE ANTENNA DRIVEN BY A COAXIAL TRANSMISSION LINE
David C. Chang Jun. 1967 42 p refs
(Contract AF 19(628)-2406; Grant NSF GK-273)
(AFCRL-67-0406; SR-19; AD-658456)

Current distribution and input admittance of an electrically thick, tubular, monopole antenna driven by a coaxial transmission over a ground plane has been investigated and compared with theoretical results. When the circumference of the antenna is comparable to a free-space wavelength, this experiment verifies that the theoretical model of a tubular dipole antenna with a delta-function excitation only on the outside surface describes the experimental situation more properly than the conventional model of a delta-function excitation on both outside and inside surfaces of the antenna. Author (TAB)

N67-40185*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ENTRY ACQUISITION AND RADIO VISIBILITY COMPUTER PROGRAM
Jerry S. Linnekin and Court F. Buell Sep. 1966 39 p refs
(NASA-TM-X-55986; X-507-66-437) CFSTI: $3.00 CSCL 17I

The program provides acquisition (azimuth and elevation) information for tracking radars; antenna look angle information for up to eight vehicle borne antennas; and blackout predictions for VHF, C-band, and S-band radars. The program was developed to enable the user to provide optimum tracking station locations (both ship and aircraft) for an entry vehicle. The program was used in support of Apollo AS-202. Geometric diagrams depicting the earth fixed, geodetic, and body coordinate systems are given; along with the appropriate mathematical expressions. Input data is presented; and examples of computer output are given. L.S.

N67-40202*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A GROUND STATION FOR THE NIMBUS WEATHER SATELLITE AUTOMATIC PICTURE TRANSMISSION SYSTEM
Carl Eslinger and Sumin Tchen Oct. 1967 47 p refs
(NASA-TM-X-55977; X-320-67-511) CFSTI: $3.00 CSCL 09F

This report describes a Nimbus Automatic Picture Transmission (APT) system ground station set up by the authors while participating as high school students in the National Science Foundation 1966 summer student program at Goddard Space Flight Center. Their project had two objectives: (1) to give the students the opportunity to work in a technical environment in order to supplement their formal education and (2) to prove the theoretical simplicity of the APT system by having relatively inexperienced persons set up an inexpensive, operational ground station. The authors completed the project successfully by receiving and processing Nimbus APT weather pictures on a regular daily basis. They proved the simplicity of the APT system by mastering the technology in a short period of time and then setting up their ground station, plotting the spacecraft's orbits, tracking the spacecraft with an antenna modified by themselves, and receiving weather pictures equal in quality to those of other APT ground stations. Author

N67-40213# Ohio State Univ., Columbus. ElectroScience Lab.
MEMORANDUM ON ANALYSIS OF ECHO AREA OF TARGETS USING GEOMETRICAL THEORY OF DIFFRACTION AND CREEPING WAVE THEORY—2430-1
C. E. Ryan, Jr. Bedford, Mass., ESD, Jul. 1967 72 p refs
(Contract AF 19(628)-67-C-0308)
(ESD-TR-67-519; AD-658469)

A combination of creeping-wave analysis and diffraction theory has been developed for determining the radar cross section of bodies for which exact solutions are not available. The known solutions for the perfectly conducting cylinder and sphere have been used to specify attenuation and diffraction coefficients for the creeping wave. The creeping wave contribution is added to the geometrical optics or physical optics contribution from the specular point to determine the total scattered field. It is demonstrated that this type of solution is applicable to ogives, ogives with spherical caps, and prolate spheroids. Wedge diffraction theory has been combined with creeping wave analysis to calculate the edge-on backscatter of circular and ogival disks. It is necessary to modify the magnitudes, but not the forms, of the creeping wave attenuation and diffraction coefficients when treating a creeping wave on an edge. This form of analysis is adaptable to calculation of the radar cross section of composite bodies where both volumetric shapes and edges may occur in combination. Once the specular points, wedge diffraction points, and the attachment points and paths of the creeping waves are determined the computation of the scattered field is straightforward. Author (TAB)

N67-40226 Defence Research Board, Ottawa (Ontario). Computation and Analysis Section.
CALCULATION OF AREA COMMON TO TWO OVERLAPPING ELLIPSES
R. F. Rodgers Mar. 1966 94 p
(TN-65/1)

A transmitter and a receiver of electromagnetic radiation are each located on the same side of a backscattering medium plane. The transmitter emits radiation uniformly within a narrow-angle cone of elliptical cross-section, directed towards the backscattering plane; and the receiver records radiation uniformly within a narrow-angle cone of elliptical cross-section. The axes of these cones intersect on the backscattering plane. The ratio of intensities of the backscattering radiation to the directly-transmitted radiation is found. This publication describes a method of determining this ratio by calculating the area common to two overlapping ellipses. Author

N67-40251*# Westinghouse Electric Corp., Baltimore, Md. Surface Div.
R.F. TEST CONSOLE Final Report, Jul. 1965–Jan. 1967
G. R. Vaughan 10 May 1967 208 p Prepared for JPL
(Contracts NAS7-100; JPL-951140)
(NASA-CR-89685; MDF-2591) CFSTI: $3.00 CSCL 09F

The radio frequency test console is a laboratory device for evaluating advanced telemetry and ranging systems and serves for precision simulation of a deep space communications system by duplicating the characteristics of a spacecraft transmitter, the ground receiver, and the transmission media. The PM/AM subsystem includes a PM/AM transmitter, PM receiver, and coherent AM receiver. The FM subsystem consists of an FM transmitter, phase lock FM receiver, and conventional FM discriminator. A signal-to-noise summer establishes accurate signal-to-noise ratios over a dynamic range of 100 db. The phase noise instrumentation feature permits measurement of the phase noise of the PM receiver carrier tracking loop VCO at various signal-to-noise

ratios. Auxiliary test instruments are provided for measuring carrier suppression as a function of modulation index. The test console includes instruments to measure both baseband and rf signal parameters. In this report, subsystem specifications and the design plan are briefly reviewed, and design and test results are correlated with the design plan and specifications. Included are loop and module design details. K.W.

N67-40271*# Aerojet-General Corp., El Monte, Calif. Space-General

WEATHER SATELLITE PICTURE PATTERN RECOGNITION AND COMPRESSION STUDY Final Report, 16 Dec. 1966–16 Jun. 1967

16 Jun. 1967 137 p refs

(Contract NAS5-10291)

(NASA-CR-89780; Rept.-1091R-2) CFSTI: HC $3.00/MF $0.65 CSCL 09D

A pattern discrimination method was studied which utilizes established cloud pattern references through a priori calculation of basic representation vectors. The vectors are derived from a representative number of cloud patterns of each class. Once the vectors are established, their characteristics are held firm rather than updated through more conventional adaptive procedures. The method offers potential for reducing the time required to assess the information content of a weather photo through automation of the identification of cloud classes. The method is equally applicable to implementation at ground stations or on satellites. Author

N67-40287*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

MANNED SPACE FLIGHT NETWORK PREMISSION TEST AIRCRAFT SYSTEMS DESCRIPTION

31 Jan. 1964 39 p

(NASA-TM-X-55983; X-552-64-20) CFSTI: HC $3.00/MF $0.65 CSCL 09F

A guide is presented for familiarizing technically oriented personnel with the instrumentation systems that are aboard the two C-121G Super Constellation aircraft on permanent loan to NASA from the Air Force. The electronic systems described are used to test the Manned Space Flight Network's capability to support Gemini/Agena missions. Author

N67-40330 Scandinavian Committee for Satellite Telecommunication, Rao (Sweden). Experimental Ground Station.

SOME WIDE-BAND COMMUNICATION EXPERIMENTS PERFORMED WITH COMKAS, JAPAN VIA RELAY II IN JANUARY 1966

Lennart Hansson and Lars Bostroem [1966] 23 p *Its* Working Doc. No. 64

Brief descriptions and the results of some wideband communication experiments conducted with COMKAS, Japan via the Relay II satellite are presented. The experiments included audio and composite video insertion gain stability measurements; continuous random noise-audio, continuous random noise-video, and baseband noise spectrum measurements; field-time, line-time, and short-time linear distortion measurements; nonlinear distortion measurements of differential gain, synchronization nonlinearity, and intermodulation-noise loading; and both monochrome and color television transmission demonstrations with test patterns and moving pictures. R.N.A.

N67-40355# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

PULSE CODE INFORMATION RECEIVER [KODOIPUL'SNYY PRIYEMNIK INFORMATSII]

V. F. Dmitriyev 24 Feb. 1967 7 p Transl. into ENGLISH from Russian Patent no. 176623 (Appl. no. 880900/26-24, 19 Feb. 1964) 2 p

(FTD-HT-66-732; AD-658651)

A pulse-code information receiver is described. To simplify the entire system, an AND element is provided; its output is coupled to the register input, and its input is connected to the register output through the channel divider. Author (TAB)

N67-40366*# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.

SMOOTHING FOR TIME-VARYING SYSTEMS USING MEASUREMENTS CONTAINING COLORED NOISE

R. K. Mehra and A. E. Bryson, Jr. Jun. 1967 39 p refs

(Grant NGR-22-007-068)

(NASA-CR-89757; TR-1) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Bryson and Johansen (1965) described the optimal filter for the case where some measurements contained either no noise or "colored noise," i.e., noise with correlation times comparable to or larger than times of interest in the system. The present paper describes the optimal smoother for the case where some measurements contain either no noise or "colored noise." The problem is formulated as a calculus of variations problem with equality constraints, and is solved using the "sweep method" of McReynolds and Bryson (1965). The case of a single measurement containing colored noise is treated first. Then the general case and a simple example are described. Author

N67-40476 Scandinavian Committee for Satellite Telecommunication, Rao (Sweden). Experimental Ground Station.

MEASUREMENTS OF THE POINTING ERROR FOR THE AUTOMATIC STEERING SYSTEM OF THE 25 M DIAMETER ANTENNA AT THE SCANDINAVIAN EXPERIMENTAL GROUND STATION

Lennart Hansson Jan. 1967 90 p refs *Its* Working Doc. No. 72

This paper describes an extensive study that has been undertaken at a Scandinavian experimental ground station at Rao, Sweden, where a specially designed steering system, based on second order interpolation of prediction data, is used for automatic tracking of satellites. Computer errors, servo, synchronization, backlash, and beam deflection errors due to wind deformations of the antenna structure have been measured and evaluated. Pointing errors during tracking experiments with the Relay II satellite have also been measured and analysed to calculate the prediction errors for the satellite orbit. The analyses are based on calibration of the angular encoders for the antenna axis by means of radio stars. Author

N67-40497*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

NASCOM NETWORK GROUND COMMUNICATIONS RELIABILITY REPORT

Jan. 1967 74 p

(NASA-TM-X-60565; X-573-66-62) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Analytical data are presented on the Nascom Network, which is a global point-to-point communications system and integrated network to support both manned vehicle space flights and unmanned scientific satellite missions. Teletype, voice, and high speed data in real time support of NASA missions are carried by the circuits. Overall network teletype performance is assessed, and the reliability factors affecting the performance of each individual station circuit is analyzed in detail. Tabulations are presented to support the operational reliability index of the voice/data circuits which remain constant at 99%. High speed and wideband data are discussed in relation to the particular circuits involved. M.G.J.

N67-40513*# National Aeronautics and Space Administration, Washington, D. C.
SPACECRAFT TRACKING AND COMMUNICATION
1967 4 p
(NASA Facts S-2/8-67) GPO: $0.05 CSCL 17I

The three NASA tracking and communications networks, the Space Tracking and Data Acquisition Network, the Manned Space Flight Network, and the Deep Space Network, developed for unmanned satellites, manned flights, and deep space probes, respectively, are described. Also included are brief descriptions of the Minitrack System and the Range and Range rate system used to track unmanned satellites, the uses of telemetry and data processing in gathering and compiling information from satellites, the NASA Communications Network which provides high speed worldwide ground communications support for manned and unmanned space missions, a voice communications system called SCAMA (Station Conferencing And Monitoring Arrangement), and a special Manned Space Flight Network which is being established to support the Apollo project.
R.N.A.

N67-40526 Scandinavian Committee for Satellite Telecommunications, Rao (Sweden). Experimental Ground Station.
COMPUTING SATELLITE EPHEMERIS BY THE USE OF NASA'S "SPACEL BULLETIN"
Lennart Hansson Aug. 1965 12 p refs *Its* Working Doc. No. 58

The computing of satellite ephemeris by the use of NASA's "Spacel Bulletin" has been programmed on the Swedish FACIT EDB computer. The computing time of one-minute topocentric coordinates for a Relay II pass of one hours duration is 2 minutes. The pointing accuracy has been estimated by comparison with one-minute data received from The Goddard Space Flight Center. The maximum error during a pass is normally of the order of 5 minutes of arc but may occasionally rise to 15 minutes of arc.
Author

N67-40538*# National Aeronautics and Space Administration, Washington, D. C.
TELEMETRY
1967 4 p refs
(NASA FACTS S-3/8-67) GPO: $0.05 CSCL 09F

Reported is a NASA educational publication on telemetry which is part of a science series generated for junior high school general science curricula. Described are telemetry methods and techniques used for both manned and unmanned spacecraft; instrumentation associated with spacecraft telemetry systems; types of information telemetered during an orbital flight; data transmission, recording, and processing activities; and the effects of electrical disturbances on signal transmission. Included are questions related to the text, and practical experiments which serve to illustrate reported concepts.
S.C.W.

N67-40541*# Webster Research Corp., Silver Spring, Md.
RESEARCH STUDY TO DEFINE AND RECOMMEND SYSTEM IMPROVEMENTS FOR DATA DISPLAY IN THE OGO OPERATIONS CONTROL CENTER
Jun. 1967 44 p
(Contract NAS5-10515)
(NASA-CR-89740) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Real time decision making and support for multiple Orbiting Geophysical Laboratories necessitates rapid presentation in live telemetry data display. Planning, design, and implementation work for an improved system configuration for data display, satellite control, and operational support centered on a computer processing system in the operations control center for satellite commanding and data display. Software studies were oriented toward the development of broad requirements, work load estimates, and scheduling for planning purposes. Findings and recommendations for the following subjects are included in appendices: preliminary software schedule, system, implementation schedule, central processor and peripheral equipment, and cathode ray tube spacecraft status and data display system.
G.G.

N67-40544*# ADCOM, Inc., Cambridge, Mass.
SPECIAL STUDIES OF AROD SYSTEMS, CONCEPTS AND DESIGNS Final Report
Ahmad F. Ghais Oct. 1967 18 p
(Contract NAS8-20128)
(NASA-CR-89610) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Summarized are performed analyses and evaluations of the Airborne Range and Orbit Determination developmental model. The system performs its functions well with the exception of the D/F receiver. Its theoretical accuracy is at least an order of magnitude better than that with which it is possible to locate ground stations. System acquisition, tracking, and ground station control utilizing only two links are extended to incorporate a third link, operating at 138 MHz, to improve functional control from the vehicle of the ground station transponder. Three alternative methods are suggested for transfer of the direction-finding function to the 2. 3 GHz link and a two speed two-phase locked loop with superior acquisition time characteristics is recommended to improve rapid S-band link acquisition when subjected to Doppler effects.
G.G.

N67-40554 Centre National de la Recherche Scientifique, Paris (France). Groupe de Recherches Ionospheriques.
RESPONSE OF A CERTAIN BANDPASS FILTER TO A SINUSOIDAL SIGNAL OF VARIABLE FREQUENCY [REPONSE D'UN CERTAIN FILTRE PASSE-BANDE A UN SIGNAL SINUSOIDAL A FREQUENCE VARIABLE]
C. Siredey 30 Oct. 1966 87 p refs In FRENCH
(GRI/NT/61)

A theoretical and numerical study is presented for a linear bandpass filter whose frequency response obeys a square cosine law. This filter is operated by a sinusoidal signal of variable frequency. Output signal was calculated for different values of the characteristic parameters of the filter and the input signal. This permitted a study of the optimum response of the filter; and the advantages found for the filter are good resolution, weak response outside the primary peak, and absence of secondary peaks.
Transl. by M.W.R.

N67-40576*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
NASCOM NETWORK GROUND COMMUNICATIONS RELIABILITY REPORT
Mar. 1964 71 p
(NASA-TM-X-60602; X-573-63-160) CFSTI: HC $3.00/MF $0.65

Trouble tickets, circuit operations analyses, NASA circuit logs, and daily communication reports were used to prepare a reliability report on the NASCOM ground communications network. Reliability is evaluated for teletype, voice, and high-speed data circuits connecting Goddard Space Flight Center with the 20 stations around the world. Details are presented for some teletype circuits that exhibit a moderate to severe degree of fluctuating reliability, and several troublesome hf radio circuits are analyzed. The SCAMA (Station Conferencing And Monitoring Arrangement) network and high speed data circuits are also discussed.
M.W.R.

08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

N67-39392 Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.
ON THE APPLICATION OF FORMAC COMPUTER PROGRAMS TO AID IN THE SYMBOLIC FORMULATION AND SOLUTION OF ENGINEERING AND SCIENTIFIC PROBLEMS
S. K. Ferriera, L. H. Sobel, and B. G. Wrenn Jun. 1967 62 p refs
(LMSC-6-77-67-25)

An experimental symbolic manipulation system called FORMAC (FORmula MAnipulation Compiler) which utilizes the IBM 7090/94 computer that can symbolically perform mathematical operations such as differentiation, substitution, and expansion of terms, is described. Applications of FORMAC computer programs to problems in structural mechanics are presented. Author

N67-39414# Stanford Research Inst., Menlo Park, Calif.
GRAPHICAL-DATA-PROCESSING RESEARCH STUDY AND EXPERIMENTAL INVESTIGATION Quarterly Report, 1 Feb.–31 May 1967
Richard O. Duda and John H. Munson Jun. 1967 104 p ref
(Contract DA-36-039-AMC-03247(E))
(ECOM-01901-27; QR-5; Rept.-27; AD-657670)

The report describes the continuing development of preprocessing, character-classification, and context-analysis techniques for hand-printed text, such as computer coding sheets in the FORTRAN language. We discuss preprocessing operations developed to find topological features such as the perimeter, the convex hull, concavities, enclosures, and spurs of a black/white quantized figure. We describe the present status of a program, TOPO 2, which classifies characters on the basis of these and other topological features. Finally, we detail the component functions of the LISP program developed to perform FORTRAN syntax analysis on a statement-by-statement basis. Author (TAB)

N67-39436# Carnegie Inst. of Tech., Pittsburgh, Pa.
TOWARD ECONOMICAL REMOTE COMPUTER ACCESS
Michael M. Gold and Lee L. Selwyn (MIT) Jul. 1967 18 p refs
(Contracts Nonr-4102(01); ARPA SD-146)
(AFOSR-67-2018; AD-657783)

The communications services available to a user remotely accessing a time-shared computer system are considered in light of the requirements of such usage. While time-shared systems are designed to provide the computer user with the opportunity to work at his most advantageous speed and interact with the computer at his convenience, available communications services have not as yet been designed for efficient and economic time-sharing computer usage. A plan is suggested which would share communication facilities among many users; each user accessing the facility for brief periods of time. Although present technology would allow a group of users to construct a shared-carrier operation by leasing conventional circuits from the common carriers, it is suggested that the common carriers offer a sharing service, charging for communications by the amount of information transmitted rather than the time the circuit is open. Unless such a system is implemented, the full economic advantages of time-sharing cannot be attained. Author (TAB)

N67-39475# National Bureau of Standards, Washington, D. C.
THE MIGHTY MAN–COMPUTER TEAM
Ida Rhodes *In* ARL Blanch Anniv. Vol. 21 Feb. 1967 p 277–284
(See N67-39461 24-19)

The misuse of the digital automatic computer (DAC) is humorously deplored. Singled out are the rank amateurs who bungle the DACs with error-laden routines; the great diversity of machine-code structures, and the disregard of simple language in favor of time-wasting jargon; and the waste of machine time. The preparation and training needed to become an accomplished automator is stressed, and the establishment of rigid criteria for licensing applicants is proposed. M.G.J.

N67-39490# Illinois Univ., Urbana. Biological Computer Lab.
CLASSIFICATION AND ENUMERATION OF AUTONOMOUS SEQUENTIAL MACHINES
Hollis Franklin Ryan Jun. 1967 138 p refs
(Contract AF 33(615)-3890; Grants AF-AFOSR-7-67; NIH GM-10718-03)
(TR-12; AFOSR-67-1412; AD-653999)

A study is reported of the structure of the state transition graphs of autonomous sequential machines. (An autonomous sequential machine can be viewed as an isolated, discrete information processing system). The structural properties of the graphs are formally described. A state transition graph is proved to have a unique partitioning into components. It is also proved that a component has a canonical partition into functional rooted trees, and a functional rooted tree can be decomposed into a forest of functional rooted trees. Using the structural properties of the state transition graphs, nested classification systems are defined for the set of autonomous sequential machines having labeled states and for the set of autonomous sequential machines having unlabeled states. All the enumeration problems associated with the classification systems are solved. Expressions are given for the number of connected labeled machines and the number of connected unlabeled machines. Solutions are also given for several counting problems of more general application. Recursive formulas were found for counting labeled and unlabeled rooted trees. The problem of finding the number of cyclic permutions with non-distinct elements is solved; a formula for calculating the coefficients of the Bell polynomials is given. Numerical results are tabulated for autonomous sequential machines having from one to five states. Author (TAB)

N67-39516# California Univ., Los Angeles. Dept. of Engineering.
THE DESIGN OF A GRAPHIC DISPLAY SYSTEM
Barry B. Coggan Aug. 1967 195 p refs
(Rept.-67-36; AD-658314)

The study describes the basic specifications for a Graphic Display System that is designed to handle two areas of application: (1) Use as a special-purpose device for the control of an Instrumentation System, and observation. (2) Use as a general purpose display device that is capable of defining reasonably complex structures which will be useful to a broad field of application programs. Existing systems are first surveyed, the basic concepts of Engineering graphics are studied, and specific Instrumentation display requirements are discussed. Finally, this information is used to derive the basic specification for a Visual Information Processor (VIP) that will satisfy the constraints. Author (TAB)

N67-39517*# Texas Univ., Austin. Coll. of Engineering.
ON THE STRUCTURE OF SEQUENTIAL MACHINE REALIZATIONS
Charles A. Harlow and Clarence L. Coates 19 Jul. 1967 81 p refs
(Grants NGR-44-012-449; NSF GP-2724; NSF GK-1146X; AF-AFOSR-766-66)
(NASA-CR-89531; TR-27; AD-657757) CSCL 09B

In most studies of the structure of sequential machines there has been a tacit assumption that the machine was to be realized with unit delay memory elements. In this report we consider sequential machines that are realized with either trigger or set-reset flip-flop memory elements. It is shown that the relation called a partition pair which predicts the dependence of the input functions to unit delay memory elements does not predict the dependence of the input functions to trigger or set-reset flip-flop memory elements. In this paper we define relations called t-pairs and r-pairs which characterize the dependence of the input functions to trigger and set-reset flip-flop memory elements respectively. It is found that these relations do not have all the algebraic properties that partition pairs possess. Feedback in sequential machines that are realized with trigger or set-reset flip-flop memory elements is also studied. A method is given for determining when a machine can be realized with either trigger or set-reset flip-flop memory elements using function f for feedback. It is shown that if a sequential machine can be realized with unit delay memory elements using a function f for feedback then it can be realized with set-reset flip-flops using f for feedback. It is also shown that for completely specified machines that if a machine can be realized without feedback using unit delay memory elements then it cannot be realized without feedback using trigger flip-flop memory elements. The converse statement is also true. Author (TAB)

N67-39552# Rome Air Development Center, Griffiss AFB, N. Y.
COMPILER GENERATION USING FORMAL SPECIFICATION OF PROCEDURE-ORIENTED AND MACHINE LANGUAGES
Philip Gilbert (Meas. Anal. Corp.) and William G. McLellan Aug. 1967 20 p refs Presented at the Spring Joint Computer Conf., Atlantic City, 19 Apr. 1967
(RADC-TR-67-454; AD-658029)

A compiler generation system is described which is rigorously based and which allows formal specification both of the source (procedure oriented) languages and of the object (machine oriented) languages. An intermediate or buffer language, BASE, is interposed, reducing the required transformation techniques described. The system, so far, includes those elements in BASE necessary to produce ALGOL, FORTRAN, and JOVIAL compilers. This paper was presented at the 1967 Spring Joint Computer Conference. Author (TAB)

N67-39588# Carnegie Inst. of Tech., Pittsburgh, Pa. Dept. of Computer Science.
BULK CORE IN A 360/67 TIME-SHARING SYSTEM
Hugh C. Lauer [1967] 32 p refs
(Contract ARPA SD-146)
(AFOSR-67-1968; AD-657782)

In time-sharing systems where programs and data move frequently between storage media, performance measured in terms of response time, availability, capacity, and generality depends on the ability of the system to move information quickly and promptly upon demand. Analysis of and early experiences with TSS/360 reveal that a drum-oriented system cannot meet the demands imposed by user tasks. Consequently, Carnegie Institute of Technology has replaced the drum on its 360/67 with Large Capacity Core Storage. A model of the drum system was constructed, and it was discovered that it could not support its maximum paging rate except under conditions which impose high system costs. It was also found that because of its rotating nature, it actually withdraws significant portions of memory from the usable main memory of the system. Bulk core, when operated with a simple core-to-core channel, has neither of these faults. It provides the added advantage that not all pages need be swapped--those which are not heavily used may be referenced directly by the CP. By operating selectively in both modes we expect nearly an order of magnitude better performance than is possible with a drum. Author (TAB)

N67-39605# Aerospace Corp., El Segundo, Calif. Electronics Research Lab.
A COMPUTERIZED 3-D PLOTTING PROGRAM
R. L. Mitchell Jun. 1967 18 p refs
(Contract AF 04(695)-1001)
(TR-1001(2230-46)-9; SSD-TR-67-146; AD-658857)

A conceptually simple computer plotting program has been developed that provides an efficient method of plotting a projection of a three-dimensional surface with remarkable clarity, even if the surface comprises a large amount of detail. The method consists of plotting successive parallel cuts of the surface, each displaced to establish the desired projection. Only that portion of the cut that lies above the previous cuts is then plotted. The plotting sometimes requires several hours, depending on the speed of the computer and on the complexity of the function, but the cost need not be excessive since a relatively small computer can be used. A few of the functions that have been plotted are discussed in some detail. Author (TAB)

N67-39696# Oak Ridge National Lab., Tenn. Chemical Technology Div.
A FORTRAN PROGRAM TO DRAW ISOMETRIC-TYPE PROJECTIONS WITH THE CALCOMP PLOTTER
Wallace Davis, Jr. Aug. 1967 16 p refs
(Contract W-7405-ENG-26)
(ORNL-4137) CFSTI: HC $3.00/MF $0.65

A Fortran program is described for drawing isometric and similar projections of curved lines and/or data points with the CALCOMP Digital Incremental Plotter. Author (NSA)

N67-39740# Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.
STUDY OF MODULAR SYNTHESIS OF SEQUENTIAL MACHINES Final Report, Apr. 1966-Jun. 1967
Andrew J. Nichols, III Aug. 1967 36 p refs
(Contract AF 19(628)-5875)
(LMSC-L-74-67-1; AFCRL-67-0484; AD-658867)

The problem of synthesizing sequential machines with modules with a single input is considered. It is shown that there is a one-to-one correspondence between modules and certain partitions of the set of states of the machine. These partitions are called modular partitions and it is shown that the modular partitions of a given machine are related to a structure of the machine induced from the null partition. Necessary conditions for the existence of modular partitions of various types and bounds on the number of modular partitions for a given machine are derived. These results aid the designer in the synthesis of a given machine and provide basic results for further studies of modular synthesis. Author (TAB)

N67-39780*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DIGITAL FILTER SYNTHESIS PROGRAM
Robert M. Munoz and Richard A. Moyer 25 Sep. 1967 48 p refs
(NASA-TM-X-62000) CFSTI: $3.00 CSCL 09B

A discussion of the theory and operation of a digital filter synthesis program is given. This program was written specifically to aid in the computer simulation studies of space instrument systems but it has broad general application. It allows any continuous function of a complex variable to be expressed in approximate form as a computational algorithm or difference equation. Author

N67-39778# Stanford Research Inst., Menlo Park, Calif.
PROPERTIES OF CELLULAR ARRAYS FOR LOGIC AND STORAGE

Bernard Elspas, Jack Goldberg, Charles L. Jackson, William H. Kautz, and Harold S. Stone Jul. 1967 185 p refs
(Contract AF 19(628)-5828)
(AFCRL-67-0463; SR-3; AD-658832)

This report presents results of research on cellular logic techniques. The objective of the research has been to develop techniques for the efficient realization of general logical functions in cellular arrays. The report covers the subjects of theory and application of cascade decompositions; universal logic module studies; sampled sequence detectors, serial universal logic modules, and iterative multirail cascades; programmed-logic arrays; and diagnosis and testing of cellular arrays. Author (TAB)

N67-39789*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

DESIGN AND ANALYSIS OF A RATE AUGMENTED DIGITAL-TO-ANALOG CONVERTER

Sheldon Kopelson Washington, NASA, Nov. 1967 35 p refs
(NASA-TN-D-4207) CFSTI: HC $3.00/MF $0.65 CSCL 09B

A rate augmented digital-to-analog converter for computed time-dependent data was designed and evaluated. The converter produces a smoothed continuous function by digitally incrementing the function samples at a rate proportional to the predicted function change over each sample interval. The result is continuously converted to an analog voltage; this conversion produces an output which is, in effect, the sum of a linear ramp and the function sample. The converter input data are the computed sample and the change that is predicted by solving an nth-order extrapolation formula. Results are presented of the performance of the converter system for three different functions of time; both first and second-order extrapolation formulas are used. The generalized transfer function of the formula-converter combination is derived and used to calculate transfer functions for several extrapolation formulas. For functions that are band limited to 0.05 times the sampling frequency, the results indicate that a significant improvement in smoothing can be obtained by using suitably chosen extrapolation formulas which are based upon three and four samples. The digital extrapolation technique preserves the static accuracy of the converter system and permits a simple adjustment of the system for different sampling rates. Author

N67-39790# Texas Univ., Austin. Coll. of Engineering.

UNSUPERVISED LEARNING, MINIMUM RISK ADAPTIVE PATTERN CLASSIFICATION

Charles G. Hilborn, Jr. and Demetrios G. Lainiotis 16 Aug. 1967 63 p refs
(Grants AF-AFOSR-766-66, AF-AFOSR-766-67)
(AFOSR-67-1889; TR-37; AD-657759)

A recursive Bayes optimal solution is found for the problem of sequential, multicategory pattern recognition, when unsupervised learning is required. The parametric model used for this investigation allows for (i) both constant and time-varying unknown parameter vectors, (ii) partially unknown probability laws of the hypotheses and time-varying parameters, (iii) dependence of observations of finite past as well as present hypotheses and parameters, and, most significantly, (iv) parameter-conditional dependence of both observations and the information source up to any finite Markov orders. For finite or quantized parameter spaces the optimal (minimum risk) learning system is found and shown to be realizable in recursive form with finite memory requirements. By a matrix formulation, the system is represented as a combination of delay-feedback dynamic systems. The asymptotic properties of the optimal solution are studied, and it is shown that as a result of the martingale nature of the learning sequences, the optimal system is asymptotically stable and convergent. As an illustration of the applicability of the results, the general formulation is shown to be directly applicable to the construction of optimum unsupervised learning m-ary communication receivers in the presence of such problems as lack of symbol synchronization, intersymbol interference, correlated noise, random channel parameters, unknown signal waveforms and statistically dependent symbols. Author (TAB)

N67-39829# Columbia Univ., New York. Lubrication Research Lab.

THREE-DIMENSIONAL ELASTICITY THEORY FOR FLAT-PLATE MEMORY ELEMENTS SUBJECTED TO SPACE-VARIABLE NORMAL TRACTION

H. G. Elrod and Des R. Sood Jul. 1967 65 p refs
(Contract Nonr-4259(14))
(TR-9; AD-658727)

Many of the contemporary memory elements used in high-speed digital computers are flat in the unstressed state. The present work is part of a review and enlargement of applicable elasticity theory in cases of small deformation with space-variable normal traction or pressure. (1) All flat plate results are derived directly with three-dimensional linear elasticity theory - none of the conventional intermediate assumptions being employed. (2) Within the exact theory, certain auxiliary functions are shown to satisfy conventional thin-plate differential equations. In terms of these functions, displacements, stresses, stress resultants and couples are simply expressed by formulas which are either exact, or asymptotically accurate. Boundary conditions are mathematically equivalent to those of Michell plate theory. (3) Solutions obtained from the present theory are interior solutions in the sense of Friedrichs and Dressler (3) and accommodate Kirchoff edge conditions. Their use with more general edge conditions will be the subject of a later report. Author (TAB)

N67-39831* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

GODDARD REAL TIME PROGRAMMING SYSTEM. VOLUME I: INTRODUCTION

Mar. 1965 359 p
(NASA-TN-X-60547; X-554-66-283, Vol. I) CSCL 09B

The Goddard Space Flight Center Real Time Programming System, used to support the Gemini, GT-3 and GT-4 manned missions, is described in detail. The mission profile and objectives; countdown; Cadfiss test program roll call; launch; abort phases; orbit; reentry; data systems; tracking; data acquisition; tracking networks; and voice communication procedures are outlined. IBM 7094 data processing systems; 7302 core storage; data channels; printing; card punch; tape drive; file control unit; disk storage; console control; CPU; display consoles; and other pertinent equipment used for the programming system, are described. L.S.

N67-39839# European Space Data Centre, Darmstadt (West Germany).

COMPUTER PROGRAM IN ATTITUDE PERTURBATIONS AND MAGNETIC CONTROL OF A SPIN-STABILIZED SATELLITE

H. G. Walter and K. G. Lenhart Paris, ESRO, Feb. 1967 95 p refs
(ESRO-SN-2) CFSTI: HC $3.00/MF $0.65

A description of a Fortran II program is given for the computation of the dynamic behavior of spin-stabilized satellites under the influence of various perturbation torques. It is possible to predict the influence of various control types on the direction of the spin-axis with given ideal direction. The differential equation system was integrated by means of the Runge–Kutta–Merson method. The program is flexible because of a detailed subroutine structure. Various modifications exist according to the variety of applications. For a better understanding of the program and the data input handling, an input sample with results is given as well as the program lists. Comparisons of the calculations, with experimental values (Tiros I) show very close agreement. Author (ESRO)

N67-39883# System Development Corp., Santa Monica, Calif.
A GRAPHIC TABLET DISPLAY CONSOLE FOR USE UNDER TIME-SHARING
L. Gallenson 11 Aug. 1967 18 p Presented at the Fall Joint Computer Conf., Anaheim, Calif., 14–16 Nov. 1967
(SP-2835/000/01; AD-658470)

The problems of using highly interactive graphic consoles with a time-shared processor are discussed in this paper. Some solutions to these problems are given and are illustrated in the graphic tablet display (GTD) console used with the SDC Time-Sharing System (TSS). Also described in this paper are the components of the GTD, its interface with the TSS, and its operation. The GTD console employs a rear-projection display on a RAND Tablet, improving the naturalness of man-machine communication. The GTD/TSS interface takes advantage of an existing I/O preprocessor to provide the necessary response time for most of the consoles highly interactive functions. Author (TAB)

N67-39896# Aeronutronic, Newport Beach, Calif.
AN IMAGE STORAGE TUBE COMPUTER
Jack Sklansky 25 Jul. 1967 48 p refs
(Contract Nonr-2913(00))
(TN-67-40; AD-658521)

Contents: Introduction; Basic theory; The image storage tube language; Two-storage-tube algorithms; Algorithms and commands requiring three storage tubes; An algorithm for enhancing elongated objects; Conclusions; Topological processing. TAB

N67-39920* Northwestern Univ., Evanston, Ill. Dept. of Geology.
TWO PROGRAMS FOR THE FACTOR ANALYSIS OF GEOLOGIC AND REMOTE-SENSING DATA
Robert G. Garrett Oct. 1967 103 p refs
(Grant NGR-14-007-027)
(NASA-CR-89659; Rept.-12) CSCL 09B

Two modified versions of the Manson and Imbrie Fortran II factor analysis program are presented in Fortran IV. The modified programs compute either in the R-mode or Q-mode. Both programs use the Varimax criteria for rotation, however the R-mode program uses the Promax method to obtain an oblique solution whereas the Q-mode program uses the Imbrie vector solution. The R-mode program can also be used to generate sample scores from either the rotated or oblique factor matrices. The R-mode program will compute on up to 30 variables for any volume of data whereas the Q-mode version can only work on up to 100 cases which must not have more than 100 variables measured on each. Data from a geochemical survey of a gruss area at the NASA Geological Test Site, Sonora Pass, California have been used to illustrate the use of the program. Author

N67-40067*# New Mexico State Univ., University Park.
STRIGOL: A STRING ORIENTED LANGUAGE
Edward H. Harris Sep. 1967 51 p
(Grant NGR-32-003-027)
(NASA-CR-89640) CFSTI: $3.00 CSCL 09B

A reference manual is presented on the Strigol program, which was designed to facilitate the examination and manipulation of strings of data, and to meet the need for string manipulation languages. Limited arithmetic and internal subroutine capabilities are also available. The strigol scanning algorithm is described, along with the operation of the CDC 3300 implementation, and the compilation and execution time messages. Three sample programs are given to illustrate the types of problems for which Strigol is best suited: (1) a program to find the longest common segment of two lists of data; (2) a translation from the normal infix notation used in an arithmetic expression into reverse Polish notation, such as is done during the compilation process; and (3) a program to edit text into a more readable format. The point is made that the Strigol language is simple to learn and use, and provides sufficient power for all types of symbol manipulation problems. M.G.J.

N67-40083*# Bunker-Ramo Corp., Canoga Park, Calif.
EVALUATION OF USER REACTIONS TO A PROTOTYPE ON-LINE INFORMATION RETRIEVAL SYSTEM
David Meister and Dennis J. Sullivan Washington, NASA, Oct. 1967 62 p refs
(Contract NASw-1369)
(NASA-CR-918) CFSTI: $3.00 CSCL 05B

Reactions of a user population to an operational test of an on-line system for retrieving document citations were studied at several NASA facilities. During a two month operational test period, data were collected regarding frequency of usage and degree of success encountered in conducting on-line searches. Additional data were gathered by observation, interviews, questionnaires and controlled experimental tests concerning those features of the system which were most acceptable to the user population and the adequacy with which this system could retrieve citations in comparison with off-line machine search methods. The user population used the system extensively and is interested in the implementation and extension of such a system. Results indicate, however, that users are extremely critical of system deficiencies such as down time, and response time. Included with the results and conclusions, are suggestions by users of desirable features to be included in advanced information retrieval systems. Author

N67-40127*# Honeywell, Inc., Minneapolis, Minn. Systems and Research Center.
RESEARCH ON COMPUTATIONAL AND DISPLAY REQUIREMENTS OF HUMAN CONTROL OF SPACE VEHICLE BOOSTERS, PHASE III. PART II: COMPUTER PROGRAMS AND DATA PACKAGE Final Report, 1 Mar.–31 Aug. 1967
P. A. Anderson and W. J. Eckart Aug. 1967 45 p
(Contract NAS8-20023)
(NASA-CR-89642; Rept.-12513-FR3-II) CFSTI: $3.00 CSCL 09B

This document describes a real-time trajectory program written in conjunction with the research on computation and display requirements for human control of space vehicle boosters. The program was written for a hybrid computer system composed of an SDS 9300 digital computer connected to a Pace 231RV analog computer by means of an Adage 770 link. Peripheral devices included a card reader, magnetic tapes, console typewriter, line printer, strip recorder, x-y plotter, and a 19-inch DD40 CRT scope display. A program description, including a list of subroutines used, program operation procedures, flow diagrams, and a description of the hardware used in measuring operator workload, is included. Appended to this document is the Manual Guidance Program listing. Author

N67-40144# System Development Corp., Santa Monica, Calif.
LISP 2 COMPILER CONTEXT RESOLVER LANGUAGE AND PROCESSOR SPECIFICATIONS
Jeff Barnett 26 Apr. 1967 26 p
(Contract F19628-67-C-0004)
(TM-3417/340/00; AD-658418)

The document describes the language and processor required for the Context Resolver pass of the LISP 2 compiler proposed for the IBM S/360 computer. The Context Resolver (pass II of the LISP 2 compiler) is used to macro-expand Intermediate Language inputs into a list of Context-Resolved Interlude Language function definitions. Author (TAB)

N67-40162*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
A DECOMMUTATION COMPILER

E. I. Grunby Oct. 1967 8 p
(NASA-TM-X-55970; X-565-67-483) CFSTI: HC $3.00/MF $0.65 CSCL 09B

Steps are delineated for decommutation involving a decommutation compiler whose function it is to generate machine-language instructions to accomplish these steps and check for errors in the compiler language. The following steps are listed: read input tape, declare whether the main-frame matrix is stored in memory by row or column, specific what fill characters are to be used, decommutate over a fixed list of row indices while the column indices vary, decommutate over a fixed list of column indices while the row indices vary, decommutate an arbitrary number of random elements, define a subroutine and its exit, call a subroutine, and write the decommutated data accumulated for a given experiment on a given output tape. Data are presented to describe the instruction formats for the decom compiler, with their uses, as well as details of internal compiler logic. S.P.

N67-40182# Morrissey (John) Associates, Inc., New York.
COMPUTER COMPILER ORGANIZATION STUDIES Final Report, 15 May 1966–15 May 1967
John Barbieri and J. Morrissey 15 May 1967 121 p refs
(Contract AF 19(628)-5918)
(AFCRL-67-0483; AD-658196)

This report describes the organization of compilers to realize increased system efficiency in the areas of better hardware utilization, reduced compilation overhead, and improved man–machine communication. The principal emphasis is directed to the following topics: incremental translation, re-entrant and re-usable compilers, execution using interpretive and emulation techniques as well as conventional object code processing, and conversational source language techniques for program testing and alteration.
Author (TAB)

N67-40207# Computer Command and Control Co., Washington, D. C.
A GRAPH DECOMPOSITION TECHNIQUE FOR STRUCTURING DATA
Paul A. Jensen 1 Sep. 1967 67 p refs
(Contract Nonr-4815(00))
(Rept.-106-3; AD-658756)

For a number of advanced computer applications it will be necessary to store large quantities of data concerning relationships between a procedure for structuring transitive noncommutative relational data in a series of acyclical graphs which permit rapid access to the information. It is primarily concerned with providing algorithms which determine data structures which minimize the expected search time to discover the truth of the relation between an arbitrary pair of items. To provide computationally feasible techniques, it is necessary to temper the goal of optimality somewhat, using heuristic justification to greatly reduce the set of feasible structures. The resultant techniques utilize a max-flow min-cut algorithm and dynamic programming. Author (TAB)

N67-40214# Carnegie Inst. of Tech., Pittsburgh, Pa.
A DATA DEFINITION FACILITY FOR PROGRAMMING LANGUAGES
T. A. Standish (Ph.D. Thesis) 18 May 1967 300 p
(Contract ARPA SD-146)
(AD-658042)

The dissertation presents a descriptive notation for data structures which is embedded in a programming language in such a way that the resulting language behaves as a synthetic tool for describing data and processes in a number of application areas. A series of examples including formulae, lists, flow charts, Algol text, files, matrices, organic molecules and complex variables is presented to explore the use of this tool. In addition, a small formal treatment is given dealing with the equivalence of evaluators and their data structures. TAB

N67-40248# Puerto Rico Nuclear Center, Mayaguez.
FORTRAN PROGRAM FOR CALCULATION OF NEUTRON DIFFRACTION MAGNETIC INTENSITIES
M. I. Kay and Don T. Cromer [1967] 14 p
(Contract AT(40-1)-1833)
(PRNC-78) CFSTI: HC $3.00/MF $0.65

A computer program for calculating the intensities of neutron-diffraction magnetic reflections is described. The computer program is written in Fortran for the IBM 1620. NSA

N67-40264 Scandinavian Committee for Satellite Telecommunication, Rao (Sweden). Experimental Ground Station.
AUTOMATIC DATA HANDLING AT THE SCANDINAVIAN EXPERIMENTAL GROUND STATION
Lennart Hansson Nov. 1965 20 p *Its* Working Doc. No. 58

In the Scandinavian Experimental Ground Station for satellite communication experiments an automatic data-logging system is used for recording of experimental data. This equipment is described in detail. The recorded data are punched on paper tape that is fed into an off-line computer for check, calibration and storing on magnetic tape for later analyses and presentation. This computer process is also described. Two computer programs are presented. The first one is used for presentation of data as curves printed on a high speed printer and the second one for statistical computations on the data. During the first year of operation data have been recorded, stored on magnetic tape, and analyzed, showing that the data-logging system and the computer programs are well integrated and working very satisfactorily giving a powerful tool for analyses of important ground station parameters. Author

N67-40276* International Business Machines Corp., Rockville, Md. Federal Systems Div.
GODDARD REAL TIME PROGRAMMING SYSTEM. VOLUME II: MONITOR AND I/O PROGRAMS
Greenbelt, Md., NASA. Goddard Space Flight Center, Mar. 1965 1049 p
(Contract NAS5-9762; Proj. Gemini)
(NASA-TM-X-60548; X-554-66-283, Vol. II) CSCL 09B

The real time computing programs are described for the mission support through the Gemini Titan-3 space flights. Details are given on the main controller programs, the queueing and unqueueing programs, and the associated Gemini system Macros. The programs, subroutines, and flow charts are presented. N.E.N.

N67-40277* International Business Machines Corp., Rockville, Md. Federal Systems Div.
GODDARD REAL TIME PROGRAMMING SYSTEM. VOLUME III: REAL TIME PROCESSORS
Greenbelt, Md., NASA. Goddard Space Flight Center, Mar. 1965 1335 p
(Contract NAS5-9762; Proj. Gemini)
(NASA-TM-X-60549; X-554-66-283, Vol. III) CSCL 09B

The programs are presented and described for the launch/abort and the orbit/reentry portions of the space flights through Gemini-3 space flights. The routines, subroutines, and flow charts are given. N.E.N.

N67-40278* International Business Machines Corp., Rockville, Md. Federal Systems Div.
GODDARD REAL TIME PROGRAMMING SYSTEM. VOLUME IV: NON-REAL TIME PROGRAMS

Greenbelt, Md., NASA. Goddard Space Flight Center, Mar. 1965 879 p
(Contract NAS5-9762; Proj. Gemini)
(NASA-TM-X-60550; X-554-66-283, Vol. IV) CSCL 09B

The share operating system and the orbital simulation are presented for the Gemini space flights. The share operating system, chosen because of its adaptability to the conditions imposed on a real time system, is described, and the differences between it and the share systems, and the required modifications are described. The simulation system, complicated by the need to respond dynamically to the orbit changes made by the astronauts is also discussed. The programs and flow charts are given. N.E.N.

N67-40301# Stanford Research Inst., Menlo Park, Calif.
RESEARCH ON SELF-ORGANIZING MACHINES Final Report
Richard O. Duda Sep. 1967 30 p refs
(Contract Nonr-3438(00))
(AD-658527)

This report reviews the results of a program of research on self-organizing machines. This research was primarily directed at establishing the conditions under which iterative machine-learning procedures can be guaranteed to converge. The most significant result of this effort was the development of a fairly complete theory of the linear machine, an important trainable multicategory pattern classifier. Theoretical results are summarized and related to the present state of research in pattern recognition.
Author (TAB)

N67-40341# MITRE Corp., Bedford, Mass.
MERGE
Isaish Beilin Bedford, Mass., AFSC, Electron. Systems Div., Aug. 1967 40 p
(Contract AF 19(628)-5165)
(MTR-271; ESD-TR-67-371; AD-658446)

A general purpose 7030 computer program has been written in the FORTRAN environment to merge in a single run of the program two, three, or four tape files which are the resulting output from a sort program. These files may be more than one tape in length and may be either FORTRAN or non-FORTRAN formatted. Input and output processors have been designed to handle various types of item formats; the program accepts items of fixed length, variable length - identified by a predesigned terminator - and variable length with a length defining field. Upon request, the output processor will eliminate duplicate items and/or fill in variable length records to a standard size. Author (TAB)

N67-40345# Michigan Univ., Ann Arbor. Systems Engineering Lab.
COMPUTER PROGRAMS DEALING WITH FINITE-STATE MACHINES, PART II
Thomas F. Piatkowski Jul. 1967 76 p refs
(Contract AF 30(602)-3546)
(Rept.-06920-15-T, Pt. II; SEL-TR-20, Pt. II; AD-658001)

A number of algorithms were programmed, dealing with finite-state machines; the purposes of this effort being: (1) pedagogical application, (2) the stimulation of insight, and (3) the generation of new questions and approaches. Out of a set of thirty-eight more or less different problems dealing with finite state machines, seven representatives were selected; namely: (1) simulate a given machine, (2) determine if a given machine is strongly connected, (3) determine the state equivalence classes and minimal form for a given machine, (4) determine the automorphisms and their group for a given machine, (5) determine a shortest simple adaptive diagnosing experiment for a given machine and admissible set, (6) determine an equivalent regular expression for a given machine, (7) exhibit the lattice of SP partitions for a given machine. This report, the second of two, describes the programs treating problems five through seven; the first report treating problems one through four appeared previously as AD-657 999. TAB

N67-40364# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ON THE CONSTRUCTION OF PROGRAMMING DEVICES WITH MONITORING AND CORRECTION [K POSTROYENIYU PROGRAMMIRUYUSHCHIKH USTROYSTV S KONTROLEM I KORREKTSIYEY]
M. B. Ignat'yev and V. V. Mikhaylov 18 Aug. 1967 20 p refs Transl. into ENGLISH from Akad. Nauk SSSR. Inst. Elektromekhan. Avtomat., Telemekhan. i Priborostr. (Moscow), 1964 p 161–172
(FTD-MT-67-42; TT-67-62970; AD-659022)

The report is an incorporation of redundancies into the problems under consideration which would permit the control and correction of computer solutions if they contain errors caused by the incorrectness of the calculational algorithms, and by random machine component failures. In contradistinction to the known approaches the proposed approach allows the control and correction of the solution as a whole and may be used in machines with series or parallel action of the discrete, analog, or combined types. The present paper investigates in detail the establishment of devices with controls and corrections intended for the reproduction of functions specified by finite equations. Author (TAB)

N67-40369# Michigan Univ., Ann Arbor. Systems Engineering Lab.
ON THE CONSTRUCTION OF THE LATTICE OF SP PARTITIONS
Thomas F. Piatkowski Jul. 1967 13 p ref
(Contract AF 30(602)-3546)
(SEL-TR-18; Rept.-06920-14-T; AD-658000)

The report presents a method for constructing the lattice of SP partitions for any given finite-state machine via a state-pair graph constructed directly from the machines transition function and a homomorphism which reduces a set of subgraphs to the full SP partition lattice for the machine. The method is a graphical extension of the two-state generator procedure of Hartmanis and Stearns. TAB

N67-40562# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
NATURAL COMMUNICATION WITH COMPUTERS Final Report, 15 Mar. 1965–31 Aug. 1967
Daniel G. Bobrow 31 Aug. 1967 38 p refs
(Contract AF 19(628)-5065; ARPA Order 627)
(BBN-1548; AFCRL-67-0485; AD-658829)

The report discusses results concerning problems affecting computer communications with people, other computers, and real-time devices, as found within the 2 years of the contract. TAB

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

N67-39584# Army Electronics Labs., Fort Monmouth, N. J.
PRACTICAL CONSEQUENCES OF MODAL PARAMETER CONTROL IN CRYSTAL RESONATORS

Gunter K. Guttwein, Theodore J. Lukaszek, and Arthur D. Ballato
Jun. 1967 28 p refs
(ECOM-2847; AD-658222)

The extension of the design technique to permit the fabrication of units to 150 MHz is presented along with a discussion of the latitude which exists between the conflicting constraints imposed by the nature of the crystal element. Included are charts and nomograms to facilitate the design of these units, together with attainable motional parameter values consistent with an adequately suppressed unwanted mode spectrum. This new technology is also applicable to oscillator crystals. One area explored concerns the specific problem of achieving moderate mode suppression in VHF oscillator crystals which must work in fixed-tuned circuits. Here the operating characteristics of the oscillator are such that the use of conventional designs in the crystal fabrication results in poor equipment performance. The difficulties are resolved by using energy-trapped elliptical electrodes. Not only are the original motional resistance and capacitance values preserved, but all troublesome modes are suppressed by more than 8 dB; these units perform well in the equipment. The report concludes with a discussion of certain inherent boundaries on resonator design and performance arising from intrinsic properties of quartz and vibrator configuration. Based on the Bommel, Mason, and Warner curves these boundaries are related to practical frequency ranges, orders of overtone, and values of attainable Q, including Q enhancement by mode trapping and control. Author (TAB)

N67-39638# Microwave Electronics Corp., Palo Alto, Calif.
INVESTIGATIONS OF BROADBAND FERROMAGNETIC POWER LIMITERS AND EXPANDERS AS DUPLEXING ELEMENTS FOR MICROWAVE SYSTEMS Quarterly Progress Report, 1 Mar.–31 May 1967
Peter Young Aug. 1967 29 p refs
(Contract DA-28-043-AMC-02120(E))
(ECOM-02120-4; QPR-4; AD-658202)

Coupling of an electromagnetic wave to the lowest order surface magnetostatic wave in a transversely magnetized YIG sample has been observed in S-band. Improved matching into a rutile waveguide has been achieved. Some experimental evidence has been obtained to check the dispersion curve for the surface magnetostatic mode. A new helix has been designed and fabricated, and its loss characteristic has been measured. Author (TAB)

N67-39687# Army Electronics Lab., Fort Monmouth, N. J.
FILTER CRYSTAL PARAMETER MEASUREMENTS WITH FREQUENCY-MODULATED SIGNALS: FREQUENCY RANGE 1 MHz TO 350 MHz
Frank K. Priebe Jun. 1967 110 p refs
(ECOM-2845; AD-658221)

It is shown that it is possible to extract from the crystal mode spectrum a large amount of information with an accuracy of 2-5%. The use of the mode spectrum constitutes a great savings of time compared with other (point-by-point) methods. This is particularly true if a signal source of adequately high precision is used, so that the characteristics of the frequency response can be determined with sufficient precision relative to each other. Typical mode spectra are considered, covering a frequency range from less than 1.0 MHz to at least 350 MHz. A wide variety of component instruments were used for the measurement arrangements. The parameters were studied not only as a function of the frequency mode response, but also as function of the phase-frequency and phase-amplitude response. Immittance bridges were used exclusively for the response determination. The effects of the tuning conditions of the bridge on the mode spectrum response are illustrated. Methods for determining the magnitude of the individual parameter values from the response spectrum are discussed. The minimum conductance that could be detected was of the order of 0.1 millisiemens. The investigation was not restricted to filter crystals alone; high Q, high precision crystals are also covered. Most emphasis was placed on studying a wide variety of instruments but it is by no means claimed that this study is exhaustive. It is certain that there exist many other commercial instruments which perform as good as, or better than, the ones studied, but the general nature of the techniques given are applicable in any event. Author (TAB)

N67-39747# Purdue Univ., Lafayette, Ind. School of Electrical Engineering.
P–I–N THERMO-PHOTO-VOLTAIC DIODE
R. J. Schwartz and C. W. Kim Aug. 1967 133 p refs
(Contract N00014-67-A-00226-004)
(TR-EE67-13; AD-658902)

A p-i-n photovoltaic structure is discussed and compared with a conventional p-n junction photovoltaic converter with respect to the efficiency of conversion. The structure consists of an intrinsic region facing the illumination source with interdigitated p and n regions located on the unilluminated surface. The purpose of using an intrinsic region is to obtain longer lifetimes and diffusion lengths. The heavily doped p and n regions result in larger recoverable voltages and higher open-circuit voltages under high intensity illumination. The use of an evaporation process, with suitable masks, allowed precise control of the dimensions of the interdigitated p-i-n structure and led to the formation of heavily doped junctions. Subsequently a low alloying temperature was used in order to maintain high lifetime in the intrinsic region. It was found that a device fabricated with use of Au-Sb-As for n-type doping, Al for p-type doping, and alloyed at 430C in a gas ambient yielded heavily doped junctions. The p-i-n structure has been analyzed as a two-dimensional boundary value problem under the assumptions of charge neutrality and quasineutrality. The analysis includes calculations of the carrier concentrations generated by photon absorption, the electric field which causes an internal voltage drop in the intrinsic region, and the current dependence of the junction voltage. The solutions are given in terms of elementary functions. The results are obtained in graphical form by means of a computer. It is shown that the area of the p-contacts should be twice as large as that of the n-contacts for an optimum performance. Author (TAB)

N67-39784# Autonetics, Anaheim, Calif.
FUNCTIONAL EVALUATION OF AN ELECTROLUMINESCENT DISPLAY FOR CONTROL OF A SUBMERSIBLE VEHICLE Interim Report, 1 Mar. 1966–31 Aug. 1967
Robert H. Wright and John S. Frost 7 Sep. 1967 57 p refs
(Contract N00014-66-C-0135)
(C7-2191/301; AD-657950)

An electroluminescent display for indicating position deviations and rates for a submersible vehicle in six axes of control was designed and fabricated, and performance with it was compared to performance with a conventional display panel containing comparable information. Both naive and trained subjects were used, the task being to maintain the vehicle in a hover for a 3-min. period at a reference position in the X, Y, and Z axes, and to maintain heading and level attitude. An analog computer was programmed to simulate the dynamics of a submersible vehicle, activating the selected display in response to inputs from a 6 degree-of-freedom control stick. Forcing function generators were used to provide position displacement signals, simulating deep sea currents in each translational axis. Three naive subjects were tested for 36 trials on each display. Results indicate subjects can perform a submersible hover task equally well using conventional displays or digital electroluminescent displays. Two of the naive subjects showed superior overall performance using the conventional display; the third was superior on the electroluminescent display. All three were found to be more proficient using the rotational axes of display than the translational axes on the electroluminescent display.

One of the trained subjects confirmed this tendency; the other trained subject exhibited superior performance on the electroluminescent display in 5 of the 6 control axes. It was concluded that with appropriate display design, the medium of electroluminescence appears to be satisfactory for the control of this class of vehicle. Author (TAB)

N67-39792# Microwave Electronics Corp., Palo Alto, Calif.
X-BAND HIGH POWER CW AMPLIFIER AND AMPLIFIER CONSOLE Final Report, 1 Jul. 1963–31 Mar. 1967
Norman H. Pond and Robert E. Eggers Aug. 1967 158 p refs
(Contract DA-36-039-AMC-03334(E))
(ECOM-03334-F; AD-658171)

A 12.5-kW, 7.7 to 8.4 GHz traveling-wave tube and its associated operating equipment has been developed. This traveling-wave tube operates at a power level of 12.5-kW CW with minimum efficiency of 35 percent. The demonstrated life of this device is in excess of 2,000 hours. This report describes in detail the electrical and mechanical properties of the traveling-wave tube and its associated console. A chronological summary of the development program and a discussion of each of the major problems encountered is given. Recommendations for future work in this general area are included. Author (TAB)

N67-39843# Loral Electronics Corp., New York.
WIDE BAND FERRIMAGNETIC LIMITER STUDY Interim Report, 1 Mar.–24 Jun. 1967
A. Christopher and J. Moyse Griffiss AFB, N. Y., RADC, Sep. 1967 17 p
(Contract F30602-67-C-0062)
(RADC-TR-67-453; AD-658890)

A complete phase analysis of the octave band all pass with electronically tunable limiter ranges is made. Two modes of operation are shown to be possible, an amplitude all pass made with no insertion loss but a 180 degree phase reversal thru the limited interval. The other mode of operation, the phase pass mode, has infinite insertion loss at the edges of the limited interval but no phase reversal. Author (TAB)

N67-39900# Army Electronics Labs., Fort Monmouth, N. J.
HIGH-POWER, FOUR-PORT JUNCTION CIRCULATOR
John L. Carter and John J. Bruscella May 1967 18 p refs
(ECOM-2841; AD-658059)

The high-power limitations of four-port junction waveguide circulators are investigated. The optimum geometry and dielectric loading are determined. The major limitation is found to be high-power breakdown. An X-band, four-port junction circulator, capable of operating at a peak power of 150 kW at a center frequency of 9.0 GHz, is described. Isolation is found to be 15 db minimum and insertion loss less than 1 db over a frequency range of 250 MHz. The best material to inhibit ferromagnetic nonlinear effects was found to be YIG, with 45% gadolinium substitution. Author (TAB)

N67-39958# Army Electronics Labs., Fort Monmouth, N. J.
DESIGN TECHNIQUES FOR VHF WIDE-BAND CRYSTAL FILTERS
Eugene J. Chabak and Joseph M. Giannotto Jun. 1967 16 p refs
(ECOM-2814; AD-658981)

Modern network synthesis techniques have given the design engineer the necessary tools to design filters with optimum performance characteristics. The realization of such designs depends primarily on the availability of components to satisfy the optimum requirements necessary. Wide-band filter designs for VHF operation have been available for some years, however, the realization of these designs became contingent on the improvement of quartz crystal fabrication techniques. The advent of the 'trapped energy' concept has made possible the fabrication of crystal units with enhanced characteristics. Suppression of spurious responses and reduction of crystal resistance now permit the design of wide-band filters in the VHF range. Utilizing a 'stretching' coil technique in half lattice circuit structures, design equations, circuit considerations and parameter values are presented. Filters operating at 68 MHz, required for the RADA program, are analyzed and described in detail to illustrate the theory of design. The report is presented in sufficient detail concerning the design and alignment procedure so that engineering personnel not directly involved with filter design can follow the design theory. Author (TAB)

N67-39990* Chrysler Corp., New Orleans, La. Space Div.
TEST REPORT FOR PRESSURE SWITCH HYDRAELECTRIC COMPANY PART NUMBER 32087 NASA DRAWING NUMBER A75M04044-HPS-2
C. L. Foy 25 Jul. 1967 51 p
(Contract NAS8-4016)
(NASA-CR-89777; TR-RE-CCSD-FO-1107-3) CSCL 09A

This report presents the results of tests performed on three specimens of a pressure switch. The actuation pressure of specimen one was out of tolerance during the initial functional and cycle tests and after the high temperature test. The actuation pressure of specimen two was out of tolerance during the initial functional and after the high temperature, vibration, explosion, and cycle tests. The actuation pressure of specimen three was out of tolerance during the initial functional and after the salt fog test. The unit was not adjustable to the minimum required actuation pressure during the adjustability tests performed after the salt fog and cycle tests. Author

N67-39991* Chrysler Corp., New Orleans, La. Space Div.
TEST REPORT FOR PRESSURE SWITCH PARMATIC, INCORPORATED—PART NUMBER AP535-4 NASA DRAWING NUMBER A75M04044-HPS-1
C. L. Foy 24 Jul. 1967 51 p
(Contract NAS8-4016)
(NASA-CR-89776; TR-RE-CCSD-FO-1106-3) CSCL 09A

This report presents the results of tests performed on three specimens of a pressure switch. The actuation pressure of specimen 1 was out of tolerance during the initial functional, low and high temperature tests, vibration and cycle tests and after the temperature and salt fog tests. The insulation resistance was below specification levels after the temperature tests. The actuation pressure of specimen 2 was out of tolerance during the initial functional and cycle tests and after the temperature and explosion tests. The contact voltage drop between pins A and B exceeded the specified level after 2, 3, 4, and 5 thousand cycles of the cycle test. The actuation pressure of specimen 3 was out of tolerance during the initial functional and after the salt fog test. Specimen 3 would not operate prior to the cycle tests due to deterioration caused by the salt fog test. Author

N67-40008* Honeywell, Inc., St. Petersburg, Fla. Aerospace Div.
LARGE SCALE INTEGRATED CIRCUIT DEVELOPMENT Quarterly Report
15 Sep. 1967 76 p Prepared for JPL
(Contracts NAS7-100; JPL-951941)
(NASA-CR-89630; Rept.-951941-QR-1) CSCL 09C

A low-power monolithic integrated circuit which is able to perform a 10-bit Counter/Shift Register function, and can be used for counting and shifting, scaling, and temporary storage was designed and fabricated. Two approaches to the mechanization were considered: (1) a circuit which can be used as a counter or

shift register, the mode of operation depending upon the logical condition existing at certain of the input terminals; and (2) a configuration in which the counter and shift register functions can be executed entirely independently. Gates are provided so that counter data can be transferred to the shift register. The second version has been developed, and two circuits, one for operation from a 5 volt±10% supply and the other for operation from a 3.5–6 volt supply were designed. The development of the latter device has proceeded through mask-making, and it will be provided with two metallization options, one of which makes all ten outputs available, the other allowing access to the ten counter set inputs. Author

N67-40039# Eidgenossische Technische Hochschule, Zurich (Switzerland).
CONTROLLABLE BROADBAND DIFFERENTIAL PHASE-SHIFTER WITH CAPACITY DIODES IN THE MICROWAVE REGIONS [STEUERBARE, BREITBANDIGE DIFFERENZ-PHASEN SCHIEBER MIT KAPAZITAETSDIODEN IM MIKRO-WELLENGEBIET]
Charles Alfred Liechti (Ph.D. Thesis) 1967 115 p refs In GERMAN; ENGLISH Summary
(DISS-3926) CFSTI: HC $3.00/MF $0.65

A controllable broadband differential phaseshifter for low-power applications is realized by the periodic loading of two transmission lines with varactors. The diodes are periodically mounted in series with the inner conductor of each of two coaxial lines. The effect of each diode is representable by means of an equivalent circuit, some of whose elements are dependent also upon the transmission line dimensions. The independent elements are determined by direct measurement of the varactor characteristics, while the dependent ones are approximately calculated by means of available tables and curves. An analysis of the phase-shifter repeatedly incorporating this equivalent network shows that the computed phase-shift, insertion loss, and reflection coefficient agree with experimental data. The network under the condition of a frequency independent phase difference of the two transmission lines. Such transmission lines, each of which incorporated four varactors, were synthesized and built for a frequency range of 2.7 to 4.3 GHz. The phase difference is continuously controllable between 0° and 90°, and it never deviated more than ±5° from the nominal value as frequency was varied over the specified range. The VSWR at the input remained below 1.5. Author

N67-40123 Royal Aircraft Establishment, Farnborough (England).
PRESENT STATE OF PROBLEMS ENCOUNTERED IN COMMUTATION OF DC MACHINES [DNESNI STAV PROBLEMATIKY KOMUTACE STEJNOSMERNYCH STROJU]
V. Kulda Jun. 1967 23 p refs Transl. into ENGLISH from Elektrotechn. Obz. (USSR), v. 53, no. 8, 1964 p 420–425
(RAE-Lib-Trans-1238)

The author summarises the present problems of commutation of dc machines and their significance for electric drives. He recapitulates the new methods of commutation adjustment according to L.L. Lavrinovich and S.I. Roumanis, as well as by means of the Hall probe. He deals in detail with the general view on the phenomena under the brushes and on the commutator, and concludes his paper with the control of the commutator surface by a capacitance sensing element. Author

N67-40133*# Philco Corp., Blue Bell, Pa. Microelectronics Div.
DEVELOPMENT OF GLASS PASSIVATION METHOD FOR SEMICONDUCTOR DEVICES FOR SATURN SYSTEM Quarterly Progress Report, 28 Sep. 1966–28 Mar. 1967
28 Mar. 1967 93 p refs
(Contract NAS8-18043)
(NASA-CR-89617; R-518; QPR-2; QPR-3) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Material, design, and manufacturing studies were performed. The materials study covered theoretical requirements and experiments on deposited passivating film. The design study indicates that test methods were inadequate to measure ambient contamination effects on device stability. An intensified study was therefore initiated of the charge accumulation on the SiO_2 surface, thought to cause most of the device instability. Capacitive inversion and surface-field-induced inversion were studied in bipolar products in order to select a sufficiently sensitive vehicle. A revised vehicle was fabricated and studied, and the results indicate that surface-field-induced inversion is less likely to occur on glassed units. The advantages of the additional glass layer were considered in the manufacturing study. The best time for applying glass encapsulation and the passivating layer during manufacture was found to be while the microcircuits are still in wafer form, not following assembly of the discrete chip. The revised vehicle proved to be sensitive to surface charge accumulation, and units were prepared for a performance evaluation. A reliability test program for the revised vehicle is described. K.W.

N67-40201 European Atomic Energy Community, Geel (Belgium).
WINDOW DISCRIMINATOR WITH TUNNEL DIODES
E. Sattler Aug. 1967 31 p refs
(EUR-3551.e)

A window discriminator has been developed using tunnel diodes as threshold stages. The window width is variable between 10 mV and 210 mV for a range of the base line threshold level from 10 mV to 210 mV. The thresholds remain constant for a given dial setting down to a pulse width (FWHM) of 5 ns. The discriminator output pulses can be used for timing to a certain extent, because of the constant time interval between the lower threshold trigger and the output of the discriminator due to utilization of "leading edge trigger" technique. Author

N67-40229*# Westinghouse Electric Corp., Youngwood, Pa. Semiconductor Div.
DESIGN AND DEVELOPMENT OF A HIGH POWER, LOW SATURATION VOLTAGE SILICON SWITCHING TRANSISTOR Quarterly Report
Ernest R. Stonebraker Oct. 1967 19 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952043)
(NASA-CR-89750; QR-1) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Following the development of a silicon transistor with 0.2V saturation drop at the rate of 75A, the present effort is to attain a design goal of 0.1V under the same conditions. The use of single chip, thin silicon and two methods of generating the symmetrical junction design for low saturation voltage are described. The computer optimized topographical design has been completed and results are presented. Materials acquired for experimental work are reported. Author

N67-40242# New York Univ., N. Y. Dept. of Electrical Engineering.
ACTIVE RC DELAY NETWORKS USING OPERATIONAL AMPLIFIERS Interim Scientific Report
John F. O'Neill May 1967 31 p refs Sponsored jointly by Bell Telephone Lab.
(Contract AF 19(628)-5537)
(AFCRL-67-0333; TR-400-159; SR-6; AD-658020)

It has been shown that an active lattice connection of two pole subcircuits, or resonators, is an effective structure for

active RC transfer function synthesis. This arrangement is especially attractive when non-minimum phase functions are to be realized, in that the replacement ratio of amplifiers to coils is low, and the lattice is therefore economical. In this paper, several methods for applying the active lattice to multipole delay networks are discussed, and an example four-pole constant delay network is treated in detail. Author (TAB)

N67-40263# General Electric Co., Schenectady, N. Y.
SHORT INTERACTION CROSSED-FIELD AMPLIFIER Quarterly Progress Report, 1 Mar.–31 May 1967
R. G. Lock Sep. 1967 45 p refs
(Contract DA-28-043-AMC-02268(E))
(ECOM-02268-4; QR-4; AD-658993)

The purpose of this study is to develop a novel, injected-beam, non - re-entrant crossed-field amplifier employing a cycloiding electron beam. Fast bunching of the cycloiding beam occurs since the unfavorably phased electrons are collected on the sole as interaction with the RF field begins. The activity of the fourth quarter centered around testing a cycloiding-beam amplifier in a demountable vacuum enclosure. To date, the testing has mainly been effective in uncovering situations requiring correction in the tube and test equipment. Therefore, a complete evaluation of the amplifier remains to be accomplished, although evidence of the quick bunching of the beam has already been demonstrated. Author (TAB)

N67-40319*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
PRESENT AND FUTURE STATE OF THE ART IN GUIDANCE COMPUTER MEMORIES
Robert C. Ricci Washington, NASA, Nov. 1967 18 p refs
(NASA-TN-D-4224) CFSTI: HC$3.00/MF$0.65 CSCL 09B

A survey of the present and anticipated state of the art for 1970–1972 in guidance computer main memories is presented. The selection of memory components for use in advanced guidance computer applications motivates the work reported. Non-destructive read-out (NDRO) vs. destructive read-out (DRO) type memory techniques and technologies are discussed, with particular reference to six types of advanced solid-state memory devices: magnetic cores, plated wire, planar-magnetic thin films, etched-permalloy toroids, monolithic ferrites, and integrated-circuit memories. Present characteristics of these devices are compared, and a summary of anticipated characteristics of memory devices for 1970–1972 is detailed. Memory technologies available for implementation of a system-concept breadboard in 1967, as well as those most likely available for a prototype advanced guidance computer for flight in 1970–1972, are likewise identified. Author

N67-40372# Varian Associates, Palo Alto, Calif.
STUDY OF METHODS TO IMPROVE HIGH POWER KLYSTRON LIFE AND RELIABILITY Quarterly Report, 1 Apr.–30 Jun. 1967
John Brookshier Jun. 1967 21 p refs
(Contract DAAB07-67-C-0228)
(Rept.-364-2Q; QR-2; AD-658077)

Studies were conducted in the following areas. (1) Filament Studies: The cycling test on three filaments under dc conditions at rated power was completed; Bell jar tests at 20% excess power were completed; Tests are continuing on seven diodes (three with ac on heaters and four with dc on heaters); Six new testers with modified cathode structures will be placed on the test rack. (2) Window Studies: The test setup for studying arcs was completed, including the arc generator and arc protection circuits; A number of tests were made on two half-wave thick block windows to determine the effect of arcs striking the window; One window was tested to destruction. Author (TAB)

N67-40383# Varian Associates, San Carlos, Calif.
TRANSMITTER TUBE INVESTIGATION Final Report, 1 Apr. 1966–30 Apr. 1967
C. Marshall Loring and Gordon Liljegren Griffiss AFB, N. Y., RADC, Aug. 1967 134 p refs
(Contract AF 30(602)-4205)
(RADC-TR-67-343; TR-67-10; AD-658491)

An investigation was made of characteristics of certain h.p.h.f. tubes capable of at least 100KW peak output power at up to 32 MHz which contribute to the generation of individual spurious lines in the transmitted spectrum in excess of 90db below the maximum output power. The objective was to identify noise sources within the tubes and recommend design changes to reduce the spurious outputs to the desired levels. The program resulted in a thorough noise generation evaluation of the particular class of tubes, recommended design changes to further reduce the noise generation, and noted significant factors that should enable equipment designers to minimize the noise outputs of existing tubes. Author (TAB)

N67-40399# General Electric Co., Owensboro, Ky. Tube Dept.
C-BAND AND X-BAND DUAL FUNCTION OSCILLATORS Quarterly Report, 1 Mar.–31 May 1967
J. D. Marshall and J. B. Quirk Ft. Monmouth, N. J., Army Electron. Command, Sep. 1967 16 p refs
(Contract DA-28-043-AMC-02340(E))
(RCS-OSD-1366; ECOM-02340-4; QR-4; AD-659009)

The triode development phase has continued with major effort now being directed toward X-band operation. The bonded heater-cathode structure is being used exclusively for current investigations. Grid structures still being studied are an interlaced crosswire design and a photoetched support frame design. C-band performance with good power output, I-f frequency, and tuning range has been demonstrated using tubes incorporating the latter named grid structure. This design also provided a clean spectrum with very low frequency modulation. Electrical tests on Oscillator DC-55 were made with very good results. Cross checks between Oscillator DC-55 and Oscillator DC-51 revealed no significant differences. Another oscillator (Oscillator DC-56) was designed and built for the rapid evaluation of tubes. Oscillator DC-56 features spring and finger contacts to the tube in order to facilitate rapid insertion and removal of the tube from the circuit. In the electrical tests of Oscillator DC-55, those tubes which showed little output on the grid excitation test, produced negligible frequency modulation of the r-f output. A check of the effect of load impedance variations was made by introducing a VSWR of 1.5:1 and varying it through all phases. Author (TAB)

N67-40409# United Kingdom Atomic Energy Authority, Harwell (England). Electronics and Applied Physics Div.
CALCULATION OF NOISE/SIGNAL RATIO OF A NUCLEAR PULSE AMPLIFIER EMPLOYING GATED ACTIVE INTEGRATION
M. O. Deighton May 1967 59 p refs
(AERE-R-5021) CFSTI: HC$3.00/MF$0.65

A method of calculating noise in pulse-amplifying systems, such as those employed in nuclear pulse spectrometry, is presented. The method is a time-domain one and is thus specially suitable for cases where the pulse processing involves a mixture of analog and digital techniques (e.g., gating, active integration, etc.). Several such systems have been proposed in the recent literature. It also has positive advantages when applied to certain more conventional arrangements; for example, those employing single or multiple delay-line shaping. The detailed analysis given here is an example of its application to active integrator systems. Two types of integrator are analysed, in one of which the CR coupling time constant is switched. This system, with proper choice of parameters, yields a noise/signal ratio only 1.6% greater than the ideal

cusp-response amplifier. Results are presented in the form of noise maps for each of five versions of the active integration. For comparison, the noise map of a conventional single-CR amplifier is also included. Author

N67-40585*# Goodyear Aerospace Corp., Akron, Ohio.
DEVELOPMENT OF FLIGHT CHECK-OUT SYSTEM Final Report
J. M. Bowyer and D. P. Bickel 28 Mar. 1967 33 p
(Contract NAS8-20598)
(NASA-CR-89739; GER-13198) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Two operating Flight Check-Out System breadboards were designed, constructed, and tested. Using a combination of analog and digital techniques, circuitry was developed that will evaluate the response of a guidance servo loop to a given forcing function. During an evaluation the Flight Check-Out System generates a programmed function that is compared to the actual response and yields an error evaluation that is indicative of the actual loop state of readiness. Two plug-in cards were constructed for each breadboard to evaluate a typical output response curve. Although the circuitry was designed for microminiature packaging techniques, it was delivered on conventional printed circuit boards to facilitate experimentation. Author

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N67-39419# Utah Univ., Salt Lake City. Electrical Engineering Dept.
STUDY OF TRANSVERSE WAVE INTERACTIONS Third Triannual Report, Jan. 1–Apr. 30, 1967
R. L. Schriever, K. I. Talbot, C. H. Durney, and R. W. Grow Aug. 1967 49 p refs
(Contract DA-28-043-AMC-01279(E))
(UTEC-MD-67-030; Rept.-7; ECOM-01279-7; AD-658084)

The purpose of this project is to analytically and experimentally evaluate the interaction of waves in a wave guide with waves on a rotating electron beam. The methods of analysis include use of a general coupled-mode theory, a ballistic computer program, and an experimental evaluation. A new tube is being constructed in which the interaction current can be measured, and the reflection of power in the interaction will be reduced. Space-charge effects have been found to split the longitudinal modes so that they are no longer degenerate. Their effect on the coupling coefficients is small, and can be neglected in the first-order perturbation theory. The multiple-beam interaction has been analyzed, and it has been found that the single-beam analysis can be used if the d-c beam current of the multiple beam is replaced by an effective d-c beam current. Boundary conditions are imposed upon the five interacting modes, and it is found that only three waves are excited in the system. Two of these waves travel at beta sub e and are not excited. This allows the start-oscillations conditions to be found as a function of the device parameters for the backward-wave interactions. The problem of power saturation of the backward-wave oscillations has been initiated. Small-signal theory is used to determine an expression for the efficiency. The axial bunching in the O-type backward-wave oscillator is examined to determine how it is related to the a-c current for power saturation so that criteria for determining power saturation may be established for our device. Author (TAB)

N67-39426# Air Force Academy, Colo. Frank J. Seiler Research Lab.
DESIGN FOR MAINTENANCE OF THE SYSTEM BANDWIDTH IN THE PRESENCE OF PARAMETER CHANGES
Bernard S. Morgan, Jr. Mar. 1967 4 p refs
(SRL-67-0007; AD-658022)

A design procedure for maintaining a systems bandwidth essentially constant in the presence of parameter variations is presented. The procedure is applicable to a single input-output plant. The plant is compensated by integral control and then state variable feedback. The use of the integral control requires that a procedure for specifying the closed loop poles of a system by state variable feedback be modified. This modification and the use of sensitivity functions which relate how the closed loop poles vary with incremental changes in the plant parameters form the basis for the design procedure. The result is a systematic procedure which permits the selection of the closed loop poles so that these poles essentially track the zeros as the parameters change. An illustrative example is used to demonstrate the application of the design procedure. Author (TAB)

N67-39480# Texas Univ., Austin. Labs. for Electronics and Related Science Research.
MINIMIZATION OF BOOLEAN FUNCTIONS CONTAINING ARBITRARY PARAMETERS Interim Scientific Report
Kenneth E. Kirsch and Charles H. Roth, Jr. 21 Aug. 1967 76 p refs
(Grant AF-AFOSR-766-67)
(AFOSR-67-1891; TR-38; AD-657760)

Design of flip-flop input networks, realization of incompletely specified state tables, design of asynchronous sequential networks, state assignment, and other logic design problems can lead to Boolean functions which contain arbitrary parameters. These parameters are a generalization of dont care conditions and may be assigned arbitrary values so as to minimize the cost of realizing the functions. A modification of the Quine-McCluskey procedure permits minimization of arbitrary parameter functions. A prime implicant list is developed in terms of the parameters and is used to derive a conditional prime implicant chart. Minimum solutions are obtained from this chart by a modified Petrick method or by branching. A second method for minimizing arbitrary-parameter functions treats a function of m parameters and n variables as an (m+n)-variable function. The prime implicants of this function are derived by iterated consensus and then modified to obtain the conditional prime implicant chart. Both methods have been generalized to the multiple-output case. Author (TAB)

N67-39483*# Brown Univ., Providence, R. I. Center for Dynamical Systems.
ON THE OPTIMAL CONTROL OF A SYSTEM GOVERNED BY A LINEAR PARABOLIC EQUATION WITH WHITE NOISE INPUTS
H. J. Kushner [1964] 36 p refs
(Grants NGR-40-002-015; NSF GK-967; AF-AFOSR-693-67)
(NASA-CR-89588) CFSTI: HC $3.00/MF $0.65 CSCL 09C

A mathematical discussion is presented on systems with linear controls appearing linearly in the stochastic partial differential equation. Results on processes with a vector parameter set are given, along with the properties of stochastic integrals depending on a scalar time parameter. The optimality and approximation in policy space results are discussed. N.E.N.

N67-39530* Connecticut Univ., Storrs. Dept. of Electrical Engineering.
DETERMINATION OF A REALISTIC ERROR BOUND FOR A CLASS OF IMPERFECT NONLINEAR CONTROLLERS
T. M. Taylor Oct. 1967 31 p refs
(Grant NsG-309)
(NASA-CR-89633) CSCL 09C

Imperfections arising during the corrective feedback generation process in nonlinear controllers, synthesized using Liapunov techniques, are investigated to determine their effects on controller stability. A problem was mathematically formulated in a vector differential equation representing single-input, single-output nonlinear, time varying n^{th}-order control systems. The imperfect control is considered which results when the signum function is approximated by some practical element such as a saturating amplifier, a relay with dead zone, or hysteresis, or when bounded additive transducer noise enters into the measurement of the signum function argument, $\gamma(x)$. Boundedness of solutions in the region of imperfect control and throughout the domain of asymptotic stability is considered. Systems designed from definite Liapunov functions as though they were designed from semi-definite functions are also considered. The bound development is illustrated on a second-order control system with transducer noise imperfection and a fourth-order system with hysteresis. Extension of the bound development to non-canonic systems is also investigated. E.C.

N67-39541# Ballistic Research Labs., Aberdeen Proving Ground, Md.
A METHOD FOR ESTABLISHING REALIZABLE NETWORKS OF ELECTRONIC DEVICES
Harold Raub Jul. 1967 38 p
(BRL-MR-1857; AD-657560)

A method is developed for the characterization of active solid-state devices when used at high frequencies. This requires establishment of a technique for obtaining realizable networks which provide accurate representations of the devices over a broad frequency spectrum. The process can be helpful in the design of circuits using vacuum tubes as well as various solid-state electron devices such as transistors, especially in the UHF region where parasitics play an important role. The procedure entails many measurements but provides information which may not be available by other methods. Author (TAB)

N67-39560# Illinois Univ., Urbana. Coordinated Science Lab.
SIMPLIFIED SWITCHING FUNCTIONS FOR TIME-OPTIMAL CONTROL SYSTEMS
Harry Schmeichel Aug. 1967 42 p refs
(Contract DA-28-043-AMC-00073(E))
(R-365; AD-658073)

A method is given to derive simplified switching functions for the design of third or higher order, time-optimal control systems. The type of system, that is considered, is characterized by small parameters which increase the order of the system. The sensitivity functions with respect to these small parameters has been the main tool of analysis. Two existing methods have been used to determine special initial conditions for the sensitivity equations because these equations are discontinuous at $t = 0$. It is shown that the same methods can be applied to deal with the discontinuity of the sensitivity functions at the switching time by a transformation of the original system. This investigation above all demonstrates how sensitivity functions with respect to small parameters, that change the system order, can be used to greatly simplify the analysis of higher order systems. TAB

N67-39570# Pennsylvania Research Associates, Inc., Philadelphia.
SELF-REPAIR THEORY INVESTIGATION Quarterly Report, 1 Jan.–31 Mar. 1967
Edward W. Veitch Jul. 1967 41 p refs
(Contract DA-28-043-AMC-02344(E))
(ECOM-02344-3; QR-3; AD-657671)

The report is the third of a study to develop a theory of self repair in digital nets via fault diagnosis and automatic circuit replacement. The technique of factoring the Sequential Prime Implicant Form of the sequential digital net is extended to show how monitoring circuitry can be added to detect failures and switch in replacement circuitry. Author (TAB)

N67-39619# Army Electronics Labs., Fort Monmouth, N. J.
APPLICATION OF BOOLEAN ALGEBRA TO ANALYSIS AND SIMULATION OF NETWORKS
Robert M. Dunn Jul. 1967 11 p refs
(ECOM-2856; AD-658980)

An application of revised techniques of Boolean matrix algebra is made to network analysis and simulation. Two classes of networks are discussed—transportation/communication and classification/information retrieval. The advantage of the technique is high-speed computation for relatively large networks, e.g., >1,000 elements. Author (TAB)

N67-39672* Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
SENSITIVITY CONSIDERATIONS IN THE OPTIMAL CONTROL OF A FLEXIBLE LAUNCH VEHICLE Final Report
E. G. Rynaski, R. F. Whitbeck, and B. H. Dolbin, Jr. Jun. 1967 158 p refs
(Contract NAS8-18054)
(NASA-CR-89568; CAL-BE-2311-F-1) CSCL 09C

A design study of optimal control law synthesis techniques is described. The control object is the elastic launch vehicle, which is subject to parameter variations and uncertainties. The sensitivity aspects of linear optimal control as applied to this problem and methods to reduce the sensitivity of the control system design were investigated. Three basic approaches were considered: (1) The conceptual synthesis of compensation networks, based upon knowledge of the variations, which will minimize the expected value of a quadratic performance index. (2) The construction of an auxiliary sensitivity vector which can be included in a quadratic performance index to minimize the sensitivity of the system along with the vehicle states and the control. (3) A definition of minimum eigenvalue sensitivity as a function of sensor configurations (type and body station) is developed. A secondary effort studied methods of simplifying and approximating optimal control laws for the launch vehicle. Also, guidelines for the selection of compensation networks for the optimal control law are postulated. The results of the study are presented, along with examples using the launch vehicle equations of motion, and conclusions concerning the applicability of the results to the launch vehicle problem. Author

N67-39718*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
DECOUPLING IN THE DESIGN AND SYNTHESIS OF MULTIVARIABLE CONTROL SYSTEMS
Peter L. Falb (Brown Univ.) and William A. Wolovich Washington, NASA, Oct. 1967 31 p refs
(NASA-TN-D-4219) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Necessary and sufficient conditions for the "decoupling" of an m-input, m-output time-invariant linear system using state variable feedback are determined. Given a system which satisfies these conditions, i.e., which can be decoupled by state variable feedback, the class ϕ of all feedback matrices which decouple the system is characterized. The characterization of ϕ is used to determine the number of closed loop poles which can be specified for the decoupled system and to develop a synthesis technique for the realization of desired closed loop pole configurations. Transfer matrix consequences of coupling are examined and practical implications discussed through numerical examples. Author

N67-39735# Air Force Systems Command, Griffiss AFB, N. Y. Rome Air Development Center.

STABILITY OF LINEAR TIME—VARYING NETWORKS

Keith R. Kleckner (Oakland Univ.) and Robert C. Waag Aug. 1967 18 p refs

(RADC-TR-67-326; AD-658838)

Using the second method of Liapunov, both long-known and recent stability results are motivated and presented in a logical treatment. First, the necessary and sufficient conditions for stability of the equilibrium for the A-matrix form of the network equations are summarized. Then, sufficient conditions for network stability are found. This is done in two parts. One outlines conditions that follow directly from the parameter matrices of the various network equation formulations. The other indicates conditions obtained via linear transformations. Stability conditions for fixed networks and two-element-kind time-varying networks follow as special cases of this general treatment. The results are interpreted in terms of phase space concepts and restrictions on element pumps. Examples of each of the stability conditions are given and comparisons are made between different techniques for determining network stability. In particular, a case is discussed in which the stability of a network is predicted by the present linear transformation technique but is not predicted by the modified energy function method recently given by Kuhn. Author (TAB)

N67-40009*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THE DESIGN OF A LARGE ANGLE THREE-AXIS ATTITUDE SERVOMECHANISM FOR SPACECRAFT

George Meyer [1967] 8 p Presented at the 18th Astronautical Congr., Belgrade, 1967

(NASA-TM-X-60562) CFSTI: HC $3.00/MF $0.65 CSCL 09C

A procedure for designing an attitude servo system (which adjusts the attitude and angular velocity of a spacecraft) for spacecraft which are controlled by means of an arbitrary angular momentum exchange and storage device is presented. The proposed control scheme forces the spacecraft into the desired attitude by generating torque about all three axes simultaneously. A mathematical model of the servo system is given. An example in which the system is applied to the Orbiting Astronomical Observatory, is also given. L.S.

N67-40066*# University of Southern Calif., Los Angeles. Electronic Sciences Lab.

RESEARCH ON NEW TECHNIQUES FOR THE ANALYSIS OF MANUAL CONTROL SYSTEMS Progress Report, 16 Dec. 1966–15 Jun. 1967

George A. Bekey 15 Jun. 1967 18 p

(Grant NGR-05-018-022)

(NASA-CR-89592; USCEE-227; PR-4) CSCL 09C

The adaptive behavior of human operators in manual control systems is discussed in relation to the problems posed by sudden transitions of controlled element dynamics. The objective is to develop an adaptive model of the human operator operating as an active element in various standard tracking situations, such as compensatory and pursuit closed loop tracking problems under stationary and nonstationary conditions. The proposed model is based on the idea of hierarchial control, with hierarchy defined as the graded structure of responsibility by which the various levels of organization are successively brought into play. A block diagram amplifies the text. In another approach, interest is centered on identifying unknown sampling frequencies in dynamic systems, in order to determine systematic procedures for synthesizing sampled data models in human operators. Also reported is the development and fabrication of a low inertia two degree-of-freedom hand controller. M.G.J.

N67-40087*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

NUMERICAL DIGITAL COMPUTER METHOD FOR DETERMINING THE TRANSIENT RESPONSES OF NONLINEAR AUTOMATIC SYSTEMS BASED ON CALCULATION OF THE CONVOLUTION INTEGRAL

A. V. Vul'fson Redstone Arsenal, Ala., Redstone Sci. Inform. Center, 9 Aug. 1967 19 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Elektromekhan. (Novocherkassk), no. 8, 1965 p 841–848 Prepared jointly with Army Missile Command

(NASA-TM-X-60554; RSIC-697) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Discussed is a technique for the digital computer calculation of transient processes for systems with one or more nonlinear characteristics, using an extension of the convolution technique developed by Carson for systems with one nonlinearity. The method does not require formulation of a system of first-order differential equations with subsequent programming of the right-hand sides for each problem. The output data are transfer functions of the linear part of the system. The procedure for programming the solution of a specific problem is simplified, reducing essentially to the mere input of numerical data. The nonlinearities may be given tabularly, and they may be discontinuous. Author

N67-40169# Ohio State Univ. Research Foundation, Columbus.

AN EXTENSION OF PONTRYAGIN'S MAXIMUM PRINCIPLE Technical Report, 1 Oct. 1966–30 Sep. 1967

J. T. Tou and H. H. Yeh Sep. 1967 114 p refs

(Contract Nonr-495(29))

(Rept.-3; AD-658709)

The problem of optimum control of systems whose control signals belong to a prespecified class of functions is studied. The result is formulated in a maximum principle of the Pontryagin type. The extended maximum principle states that a necessary condition for the optimum control is that the first variation of the time integral of the Hamiltonian is zero if the control function can vary in two opposite directions, is non-positive if the control function can vary in only one direction. The conditions imposed on the admissible controls are: (i) The control signals may be restricted to a prespecified class of functions which are piecewise continuous with a finite number of points of discontinuity, and which are continuous on the left at every instant under consideration (has no isolated points on the time curve). (ii) The admissible class of controls admits infinitesimal variation. (iii) The control signals satisfy some boundedness constraints. The extended maximum principle is proved for the three classes of systems: Class (1) The system is linear with respect to the control variables. Class (2) The control function of the system is a scalar or the finite variations of all components of the control vector occur in precisely the same intervals. Class (3) The points of discontinuity of the control function are not subject to variation. TAB

N67-40279* Purdue Univ., Lafayette, Ind. School of Electrical Engineering.

INVESTIGATION OF OPTIMIZATION OF ATTITUDE CONTROL SYSTEMS Annual Report, 1 Jul. 1966–31 Aug. 1967

J. Y. S. Luh 31 Aug. 1967 324 p refs Prepared for JPL

(Contracts NAS7-100; JPL-950670)

(NASA-CR-89565; AR-3) CSCL 09C

Technical discussions are presented on the continuing investigations of the optimal control systems. The optimal control of antenna directions is extended to the general stochastic optimal control problem with Markov property. The error bound is established for the Mishchenko approximate solution to Kolmogorov's backward equation. Equivalent class and prototype problems were investigated in conjunction with the stochastic optimal control problem with incomplete state-variable information. It is reported that the study of the open-loop time-optimal control of linear

time-varying systems with bounded control amplitudes and rates is completed. Extremal control conditions are discussed, and the computational results are presented in the form of inequalities which can be easily implemented on a digital computer. N.E.N.

N67-40311# Lincoln Lab., Mass. Inst. of Tech., Lexington.
GENERAL RESEARCH Quarterly Technical Summary Report, 1 May–31 Jul. 1967
Frederick C. Frick et al 15 Aug. 1967 51 p refs
(Contract AF 19(628)-5167)
(ESD-TR-67-327; AD-658834)

This Quarterly Technical Summary covers the period from 1 May through 31 July 1967. It consolidates the reports of Division 2 (Data Systems), Division 3 (Radio Physics), Division 4 (Radar), Division 7 (Engineering), and Division 8 (Solid State) on the General Research Program at Lincoln Laboratory. Author (TAB)

N67-40483# Eidgenossische Technische Hochschule, Zürich (Switzerland).
THE INFLUENCE OF STEEPLY RISING COSMIC AND ARTIFICIAL RADIATION ON THE THRESHOLD STRESS OF SPHERE AND COLUMN SURFACE SPARKGAPS [DIE EINFLUSS DER FRONTSTEILHEIT, KER KOSMISCHEN UND DER KUENSTLICHEN STRAHLUNG AUF DIE ANSPRECH-SPANNUNG VON KUGEL- UND STAB-PLATTENFUNKEN-STRECKEN]
Fred Schwab (Ph.D. Thesis) 1967 95 p refs In GERMAN
(DISS-3938) CFSTI: HC $3.00/MF $0.65

Sphere gap and rod-plate volt-time curves and spark flashover measurements for steeply rising voltage impulses were studied to determine cosmic and experimental radiation effects on discharge potential and intensity. Discharge potential for the sphere gap spark decreased hyperbolically from 130 kV to 100 kV; the spark discharge in the rod-plate system depended on the polarization factor of the rod. Ultraviolet radiation lowered the scattering factor of the sphere gap spark compared to the normal flashover width. Transl. by G.G.

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.

N67-39398* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
LAUNCH VEHICLE SAFETY ENGINEERING FOR STANDARD PAYLOAD MODULE
Preston T. Farish 20 Oct. 1965 45 p revised
(NASA-TM-X-53282) CSCL 22D

Safety requirements and procedures at the contractor and subcontractor level are discussed. The cause of many failures is attributed to vibration, shock, and humidity environmental requirements not being met; personnel errors in assembly checkout, and contaminants; and equipment malfunctions due to incompatibility between systems and subsystems and improper operating and maintenance procedures. The purpose of the program is identified as being primarily to identify methodically the system safety hazards and to provide for their timely resolution, and secondarily to provide a management system to ensure it. The procuring activity is outlined, and the subsystem and system contractor tasks are discussed. The fault tree analysis technique is described. N.E.N.

N67-39456# Cornell Aeronautical Lab., Inc., Buffalo, N. Y. Aerodynamic Research Dept.
RESEARCH ON ADVANCED GASDYNAMICS TEST FACILITIES Final Scientific Report
J. W. Daiber, F. W. Stoddard, H. M. Thompson, and R. G. Rehm
Wright-Patterson AFB, Ohio, ARL, Apr. 1967 129 p refs
(Contract AF 33(657)-8860)
(CAL-AD-1716-A-9; ARL-67-0069; AD-657775)

The report describes studies carried out on methods of improving the performance of conventional shock tubes and shock tunnels, on problems peculiar to high enthalpy test facilities, and on the application of lasers to aerodynamic facilities. A number of the studies carried out have previously been described in detail in separate reports or papers and these are summarized; those previously unreported, in particular the laser application studies and recent isentropic compression tube studies, are described in detail. Author (TAB)

N67-39499*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
CLEAN ROOMS—A SELECTED BIBLIOGRAPHY
Sep. 1967 39 p refs
(NASA-TM-X-60555; GP-385) CFSTI: HC $3.00/MF $0.65 CSCL 14B

A revised and expanded annotated bibliography is presented contamination control using clean rooms for space flight applications. N.E.N.

N67-39533# Sheffield Univ. (England). Dept. of Fuel Technology and Chemical Engineering.
TEST SECTION CONDITIONS FOR THE TAILORED INTERFACE HYPERSONIC SHOCK TUNNEL
M. P. Wood 1966 27 p
(Grant AF-EOAR-66-11)
(HIC-83-1966; AFOSR-67-2026; AD-657796)

The report contains calculated conditions expected in the test section of the Sheffield University Shock Tunnel. The driver gases used are either cold hydrogen or a mixture of hydrogen oxygen and helium ignited behind the primary diaphragm. Cold hydrogen Tailors at a primary shock Mach number of 6 and the helium mixture used at about 12. The report therefore deals with the primary shock Mach number ranges from 5 to 9 and from 9 to 14 to cover both these cases. The air in the stagnation region is expanded to test section Mach numbers of 3, 4 and 5 depending on the nozzle attached. Author (TAB)

N67-39675 Rolls-Royce, Ltd., Derby (England). Advanced Research Dept.
SHOCK TUBES—A SELECT BIBLIOGRAPHY
Graham Crowther, comp. May 1967 149 p refs
(RR/OH/287)

A compilation of data pertaining to shock tubes is presented in the form of a bibliography. Covering the period 1958 to 1966, the bibliography contains 1178 entries arranged alphabetically by author or title. Brief subject indexes are also included. S.P.

N67-39694# Sandia Corp., Albuquerque, N. Mex.
THE SANDIA CORPORATION RADIANT HEAT FACILITY
P. H. Adams, R. L. Ault, J. A. Barber, G. J. Hartman, and N. R. Keltner Aug. 1967 84 p refs
(SC-RR-67-438) CFSTI: HC $3.00/MF $0.65

The capabilities and limitations of the Radiant Heat Facility are described. The two main types of testing equipment (quartz lamp and graphite resistor heater arrays), other specialized testing capabilities, data acquisition capabilities and instrumentation design, and the theory of radiation heat transfer are discussed. Author (NSA)

N67-39733# Federal Aviation Agency, Atlantic City, N. J. Test and Evaluation Div.
RADIOACTIVE TAXI GUIDANCE TEST CATEGORY III GROUND GUIDANCE EQUIPMENT Final Report
Fred Marschall May 1967 17 p
(RD-67-9; AD-658742)

Based on the results of the demonstration, it is concluded that: (1) Radioactive taxi guidance is technically feasible. (2) Weight and volume of the present detector are excessive for the function performed. (3) The non-homogeneity of radiation source produces faulty guidance signals. (4) Pilots experience difficulty in maneuvering, due to lack of a reference to determine rate of change in the maneuver. Author (TAB)

N67-39834*# Radiation, Inc., Melbourne, Fla. Radiation Systems Div.
INTEGRATION SUPPORT EQUIPMENT FOR PROJECT IRLS Final Report
Jul. 1967 102 p
(Contract NAS5-10278)
(NASA-CR-89559) CFSTI: HC $3.00/MF $0.65 CSCL 22D

The overall characteristics of the Interrogation, Recording, and Location Subsystem of the IRLS Integration Support Equipment project, and the conclusions and recommendations derived from this project are discussed. The requirements were satisfied. Minor deviations from the proposed configuration were incorporated into the final end item. These changes were in the interest of conservation of components, logic simplification, and increased testing flexibility. The only significant change from the proposed operational sequence was the utilization of the platform modulator driver in the power control and distribution module as the signal driving mechanism for the self-check tester output. All test data that indicates adherence to the specification is included and shipped with each data package supplied with individual units. Printed-circuit card temperature tests were performed on the power supply card as a design proof test by using a temperature range of −10°C to +50°C and a voltage range of −24.5±2 vdc. All other components were specified for a temperature range of 0°C to +50°C with greater than 10% voltage variations. Author

N67-39840# European Space Technology Center, Delft (Netherlands).
ORGANIZATION OF A LAUNCHING RANGE [ORGANISATION D'UN CHAMP DE TIR]
T. B. Lagarde Paris, ESRO, Oct. 1966 24 p In FRENCH; ENGLISH summary Presented at the ESRO Summer School, Oxford, 1964
(ESRO-TM-43) CFSTI: HC $3.00/MF $0.65

In the organization of a launching range, the first important problem encountered is the choice of the site, which is a function of three factors: the safety of the local population, logistic support, and the nature of the experiments anticipated. A review of the various means employed in the running of a launching range is given in the form of an account of the operations involved (preparations for launching, firing, recovery, and data handling). Author (ESRO)

N67-40014# Environmental Science Services Administration, Atlantic City, N. J. Test and Evaluation Lab.
AN ANALYSIS OF RUNWAY VISUAL RANGE Final Report
Matthew Lefkowitz and Ernest E. Schlatter Dec. 1966 138 p refs Sponsored by FAA
(RD-66-100; AD-658537)

The results of a controlled observational program were used to validate the credibility of the current runway visual range system, and to provide a basis whereby future visual range systems and lighting methods can be compared. It was found that the current runway visual range system concept is generally credible although certain areas were noted to be considered for modification. Runway visual range for day is conservative in that most static observers could see farther than the current system predicts. The static observers visual range of runway lights by day does not conform to Allards Law when the visual illuminance threshold value is fixed. Night runway visual range, as predicted by the current system, approximates the average visual range of the static observations and generally conforms to Allards Law. The fact was established that runway visual range represents a probability of sighting light targets, and as such should be recognized by the user as not being an exact absolute value. A benchmark system is proposed whereby other visual range systems and lighting techniques can be compared. TAB

N67-40065*# Greyrad Corp., Princeton, N. J.
ANALYTICAL INVESTIGATION OF KEY PROBLEMS IN THE WATER-INJECTION-COOLED DIFFUSER FOR NUCLEAR ROCKET ENGINE/STAGE TEST STANDS 2–3 Final Report
Jerry Grey 15 Sep. 1967 145 p refs
(Contract SNPC-55)
(NASA-CR-89643; SNP-3) CFSTI: $3.00 14B

Details are given on the revisions made to the axisymmetric wet-duct mixing analysis and computer program on the feasibility of a water injection-cooled diffuser for nuclear rocket engine/stage test stands 2 and 3. The modifications permit duct pressure to vary, thereby meeting the requirements of the conservation equations; allow any axisymmetric inlet velocity profile; provide four different sets of coolant injection characteristics simultaneously; and permits variation of momentum and mass mixing rates and coolant evaporation rate. Several important effects of the changes, particularly in the area of mixing and evaporation assumptions, are demonstrated, and the complete program is included. The revised program output is compared with previous scale model test data, and flow parameter distributions are predicted for the selected geometry and inlet flow conditions. M.G.J.

N67-40151*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
STANDARD PAYLOAD MODULE DEFINITION NETWORK FOR PHASES A, B, C & D
Preston T. Farish 22 Jul. 1965 53 p
(NASA-TM-X-53299) CFSTI: HC $3.00/MF $0.65 CSCL 14A

Information intended to be used as a guideline is presented to establish the soundest practicable management baseline for planning approval and executive of future programs such as the standard payload module. The definition network and concepts proposal is presented along with preliminary definition plans. A systematic block analysis is shown to present definition network from the conceptual phase through contractor definition until the acquisition phase. Phases A, B, C, and D are outlined and defined. Author

N67-40326*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
DSIF: ASCENSION ISLAND
1966 19 p
(Contract NAS7-100)
(NASA-CR-89793; JPL-TM-33-284) CFSTI: HC $3.00/MF $0.65 CSCL 14B

The Deep Space Instrumentation Facility (DSIF), and the Ascension Island DSIF station in particular, of the Deep Space Network (DSN) designed for the tracking and acquisition of NASA mission flights, are described. Mission support functions, antennas, receiver systems, transmitters, instrumentation, data handling procedures, and interstation communications are described. L.S.

N67-40343# Air Force Missile Development Center, Holloman AFB, N. Mex. Directorate of Test Track.

SOME BASIC TECHNICAL CONSIDERATIONS FOR THE DEVELOPMENT OF ROCKET SLEDS FOR THE HYPERSONIC SPEED REGIME

Hans J. Rasmussen Jun. 1967 53 p refs
(MDC-TR-67-77; AD-658842)

Basic technical considerations for layout, design, and operation of hypersonic rocket sleds are reviewed and summarized on the basis of experience collected during experimental monorail sled runs. Emphasis is placed on selected aspects of aerodynamics, frictional and aerodynamic heating, and technological problems at the sled-rail interface. Author (TAB)

N67-40420*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

DATA MANAGEMENT STUDY, VOLUME 5. APPENDIX I: CONTRACTOR DATA PACKAGE OVERALL MANAGEMENT (MA), SCHEDULING (SC), MANNING AND FINANCIAL (MF) Final Report

R. Ginsberg, C. H. Sells, and W. S. Rosowski 28 Jul. 1967 173 p Prepared for JPL
(Contracts NAS7-100; JPL-951112)
(NASA-CR-89713; VOY-CO-FR, Vol. 5, Append. I) CFSTI: HC $3.00/MF $0.65 CSCL 05A

Data requirement descriptions, user flow diagrams, documentation relationship trees, and frequency and phasing charts for overall management, scheduling, and manning and financial aspects of the Voyager spacecraft are given in this contractor data package. Overall management data are those required to plan, review, and control Voyager activities. Scheduling data specifically define and specify all major milestones, key events, and schedules; and include the PERT and SARP documents. Data to plan, review, control, and report manpower and financial resources are included under manning and financial. M.W.R.

N67-40421*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

DATA MANAGEMENT STUDY, VOLUME 5. APPENDIX J: CONTRACTOR DATA PACKAGE PROCUREMENT AND CONTRACTING (PC) Final Report

A. T. Christensen, J. T. Hurley, R. Ginsberg and A. P. Dudeck 28 Jul. 1967 101 p Prepared for JPL
(Contracts NAS7-100; JPL-951112)
(NASA-CR-89714; VOY-CO-FR, Vol. 5, Append. J) CFSTI: HC $3.00/MF $0.65 CSCL 05A

Practices and procedures applicable to the administration of procurement and contracting for Voyager spacecraft systems are delineated in the contractor data package that includes the overall data item matrix, user flow diagrams, documentation relationship trees, and frequency and phasing charts. This data management study covers authorities, implementation procedures, contract change notices, pre-contract processes, contract management, procurement standards, and contractual reporting requirements. M.W.R.

N67-40422*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

DATA MANAGEMENT STUDY, VOLUME 5. APPENDIX K: CONTRACTOR DATA PACKAGE DATA MANAGEMENT (DM) Final Report

H. C. Thomas, A. W. Morris, J. E. Nitsche, and R. I. Toff 28 Jul. 1967 78 p Prepared for JPL
(Contracts NAS7-100; JPL-951112)
(NASA-CR-89715; VOY-CO-FR, Vol. 5, Append. K) CFSTI: HC $3.00/MF $0.65 CSCL 05B

The overall management system for identifying, defining, reviewing, and controlling any data generated and/or used by Voyager project elements are specified in this contractor data package that details data management requirement descriptions. Documentation relationship trees and frequency and phasing charts are included along with the overall data item matrix. M.W.R.

N67-40424*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

DATA MANAGEMENT STUDY. APPENDIX M: CONTRACTOR DATA REQUIREMENTS SAFETY (SA) Final Report

W. Ussler, Jr. and J. H. Behm 28 Jul. 1967 52 p
(Contract NAS7-584)
(NASA-CR-89717; VOY-DC-FR, Append. M) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Procedures, controls, methods, studies, and reporting required to insure the safety of Voyager spacecraft system operations are detailed in this contractor data package. The system safety engineering plan describes actions and activities for obtaining maximum protection of personnel, facilities, and equipment associated with all phases of the Voyager program from design to actual flight of the spacecraft. Through the application of management and engineering resources, both the awareness and resolution of potential safety problems are emphasized in these contractor data requirements. A summary safety user flow diagram along with diagrams for contract award through critical design review and for this design through launch are included. Safety data requirement descriptions are presented, a safety documentation relationship tree is included, and the data item frequency and phasing chart shows the requirements for contractor data item preparation by major project review periods. M.W.R.

N67-40425*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

DATA MANAGEMENT STUDY. APPENDIX N: CONTRACTOR DATA REQUIREMENTS SITE ACTIVATION FOR LAUNCH (AL) Final Report

B. G. MacNabb and A. W. Morris 28 Jul. 1967 47 p
(Contract NAS7-584)
(NASA-CR-89718; VOY-DC-FR, Append. N) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Activation of sites for flight operations is detailed in this contractor data package that includes documents covering the activities and requirements from facility availability to vehicle launch. Also included are data that identify organizations, locations, and responsibilities as well as lines of control for site activation by the contractor. Special tests, test support administration and logistics procedures, and problems anticipated during site activation are treated. Data that reflect the contractor activities during launch operations are included in the form of plans, procedures, sequence of events, launch criteria and constraints, and manuals. A flow diagram depicts site activation for the launch user from the critical design phase through launch. Site activation for launch data requirement descriptions are included, along with a documentation relationship tree and a data item frequency and phasing chart. M.W.R.

N67-40426*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

DATA MANAGEMENT STUDY. APPENDIX O: CONTRACTOR DATA REQUIREMENTS SCIENCE INTEGRATION (SI) Final Report

W. J. Roths and J. H. Behm 28 Jul. 1967 61 p
(Contract NAS7-584)
(NASA-CR-89719; VOY-DC-FR, Append. O) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Selection, preparation, conduct, and interpretation of scientific experiments for the Voyager spacecraft are delineated in these contractor data requirements for science integration. Specifications, reports, lists, guidelines, and manuals to successfully integrate the government-furnished equipment (GFE) experiments on the spacecraft are included in the data items. Flow diagrams, covering the period from contract award to mission acceptance review, were prepared on the assumption that the GFE scientific experiments information and hardware would be available as indicated. Science integration data requirement descriptions are presented, as is a documentation relationship tree and a data item frequency and phasing chart. M.W.R.

N67-40439* National Aeronautics and Space Administration, Washington, D. C.
SIMULATORS
1967 8 p
(NASA Facts 36, Vol. IV, No. 8) GPO: $0.10 CSCL 14B

Various NASA simulators are described which are used to test elements and situations that materials and man are expected to encounter in the earth's atmosphere or in interplanetary space. A light gas gun to study spacecraft entry into the atmospheres of the earth and other planets is described. Simulators for training the Apollo astronauts in rendezvous and docking, space navigation, and lunar landing, as well as for studying the effects of prolonged space flight on man are discussed. Also included are brief descriptions of a Saturn V test stand, a full scale lunar module mockup complete with a lunar landscape and equipment for eliminating five-sixths of an astronaut's weight, wind tunnels, aircraft cockpit simulators, a launch phase simulator, and space environmental simulators. R.N.A.

N67-40542*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
JOHN F. KENNEDY SPACE CENTER: A SELECTIVE BIBLIOGRAPHY, 1949-JULY, 1967
Jul. 1967 30 p refs
(NASA-TM-X-60557; GP-394) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Compiled in this brief organizational bibliography on the John F. Kennedy Space Center are selected reports from newspapers, periodicals, and House or Congressional hearings that deal primarily with the expansion and development of the Air Force missile test center and later on the NASA space center range. Because of the close working relationship between the Kennedy Space Center and the Air Force Eastern Test Range, articles showing evolution of the range are included. G.G.

N67-40587*# McDonnel Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B, VOLUME III: SURFACE LABORATORY SYSTEM. PART D: OPERATIONAL SUPPORT EQUIPMENT Final Report
31 Aug. 1967 242 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89697; F694, Vol. III, Pt. D) CFSTI: HC $3.00/MF $0.65 CSCL 22D

The functional descriptions and preliminary designs of the recommended Operational Support Equipment (OSE) and Mission Dependent Equipment (MDE) for the Surface Laboratory System (SLS) are presented. The approach used to establish the OSE requirements, translation of these requirements into design criteria, identification of alternative design and utilization concepts, and the rationale and critia used in selecting the preferred concept are described. Trade studies and supporting data are included. The SLS OSE includes all ground-based equipment and software required to test, checkout, transport, handle, align, install, and service the SLS from factory through launch, and the equipment and software (MDE) required to interface the SLS with the existing and planned facilities of the Deep Space Network. The OSE also includes SLS simulators and government furnished equipment required for the capsule bus integration. Author

N67-40591*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
JET PROPULSION LABORATORY WIND TUNNEL FACILITIES
1 Apr. 1967 44 p refs
(Contract NAS7-100)
(NASA-CR-89794; JPL-TM-33-335) CFSTI: HC $3.00/MF $0.65 CSCL 14B

Technical and operating information pertaining to wind tunnels to be used in performing planning necessary to conduct aerodynamic tests is presented. The wind tunnel facilities discussed include a 20-inch supersonic wind tunnel and a 21-inch hypersonic wind tunnel. Both are of the continuous-flow variable-density type and each utilizes a two-dimensional flexible nozzle that can provide an infinite choice of test section Mach numbers within a specified range. Maximum model sizing determination, operation conditions, nozzle calibration, model suspension systems, design requirements, test instrumentation, data acquisition and processing, and testing capabilities are discussed. Accompanying illustrations and figures are included. S.P.

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

N67-39415# Ohio State Univ. Research Foundation, Columbus.
ANALYTICAL STUDIES OF THE EFFECTS OF IONIZATION ON FLUID FLOWS
T. Chuang and H. Velkoff Jun. 1967 76 p refs
(Contract DA-31-124-ARO(D)-246)
(TR-6; AD-657582)

Unusually high pressure drops and flow distortions were observed in a previous experimental program involving laminar flow of a gas in a channel under the action of a corona discharge in a transverse electric field. A hypothesis postulated by Velkoff to explain the phenomenon is extended to the case of laminar boundary layer flow over a flat plate. The problem on hand is found to be analogous to the laminar boundary layer flow in a transverse magnetic field. Three other mechanisms proposed to interpret the above experimental findings are also investigated. The increase in viscosity of a gas because of the ions is not likely and, because of the smallness of ion density, the effect on ion-neutral particle interactions on the flow is believed to be small. One possible mechanism which may explain the phenomenon is the secondary flow resulting from electro-hydrodynamic instability. It is found theoretically that Taylor vortices can be induced in a quiescent fluid between two concentric cylinders under the action of a corona discharge. The Taylor Number of the problem is defined and shown to represent the ratio of the destabilizing electrostatic force to the stabilizing viscous force. It is also found that Goertler vortices can occur in laminar boundary layer over a flat plate provided the applied electric field and the charge density distribution satisfy the condition for instability. Author (TAB)

N67-39430 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
THE JET ANALYSIS BY THE METHOD OF PRINCIPAL AXIS [BADANIE SZESCIORAMIENNYCH ODDZIALYWAN π^+p METODA OSI GEOWNYCH]
Marian Danysz and Wojciech Wojcik 1967 15 p refs Transl. into ENGLISH from Polish
(INR-P-807/VI/PH) Available from Nucl. Energy Inform. Center, Warsaw

The analysis of six prong jets at 8 GeV/c π^+p interactions by the method of principal axis does not show the existence of well separated bodies which could be identified as the known resonances. The shape of the jets does not show the significant flatness. Author

N67-39438# Wisconsin Univ., Madison. Mathematics Research Center.
ON A QUASI-LINEAR ELLIPTIC EQUATION ARISING IN THE THEORY OF NON-NEWTONIAN FLUIDS
C. W. Cryer May 1967 16 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-734; AD-657572)

The equation (phi subscript x/(subscript q) 2s) subscript x, + (phi subscript y/(subscript q) 2s) subscript y = 0, where q squared = (phi subscript x) squared + (phi subscript y) squared, 0 = or < s < 1/2, occurs in the theory of non-Newtonian fluids. It is proved that there exists a unique solution for this equation for the case of flow through an annulus. Author (TAB)

N67-39445# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
AIR AND NITROGEN CONDENSATION IN HYPERSONIC NOZZLE FLOW Final Scientific Report
Fred L. Daum and George Gyarmathy Mar. 1967 67 p refs
(ARL-65-159; AD-657772)

Earlier experimental air condensation results were extended to lower pressures and higher Mach numbers where it was found that air behaves essentially as pure nitrogen and large amounts of supercooling are obtained. A theoretical analysis, based on established drop growth and self-nucleation concepts, supported the experimental findings. A correlation parameter governing the onset of condensation is presented. The analysis indicated that at the higher static pressures, where little or no supercooling is observed experimentally, the seemingly negligible amounts of CO2 and H2O in the wind tunnel air are sufficient to cause O2 and N2 condensation through a seeding action. A new method is presented for determining a conservative value of minimum stagnation temperature for obtaining condensation-free hypersonic flow. Author (TAB)

N67-39459# Hydronautics, Inc., Laurel, Md.
ON THE MOTIONS OF HIGH SPEED PLANING CRAFT
C. C. Hsu May 1967 56 p refs
(Contract Nonr-5153(00))
(TR-603-1; AD-658151)

The first part of the study presents a simple method, based on the known results of airfoil theory, of estimating the hydrodynamic characteristics of high speed planing craft. Comparisons between present calculations and experiments for flat and prismatic surfaces in steady triming, rolling and yawing attitudes are made. The calculations seem generally to be in good agreement with the data. The second part of the report discusses the turning and stability of planing craft. The governing equations, based on the kinematics and dynamics of rigid bodies are in many respects similar to that given for hydrofoil boats. Once the hydrodynamic characteristics are known the stability and turning performance of craft can be assessed with the aid of these equations. Author (TAB)

N67-39462# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
THE LAW-WENDROFF METHOD APPLIED TO AXIAL-SYMMETRIC SWIRL FLOW
John V. Armitage *In its* Blanch Anniv. Vol. 21 Feb. 1967 p 1–20 refs (See N67-39461 24-19)

The application of the Law–Wendroff method to axial symmetric swirl flow in a nozzle of arbitrary shape is described in terms of a system of conservation laws and the construction of a finite difference scheme. The differential equations for swirl flow in nozzle coordinates are derived, and the Jacobian matrices are obtained. For the incoming flow, the conservation laws of mass and the component of momentum are expressed in cylindrical coordinates. Methods of treating the upper boundary, the axis of symmetry, and the exit boundary are discussed. The effect of truncation errors is considered, and ways of improving computational accuracy are suggested. M.G.J.

N67-39477# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
EXPLORATIONS OF SUPERSONIC SHEAR FLOW OVER A CAVITY
Max G. Scherberg *In its* Blanch Anniv. Vol. 21 Feb. 1967 p 291–314 (See N67-39461 24-19)

An exploratory analytical investigation was made for a part of the shear layer over the flow cavity for a rearward facing step in supersonic flow. Families of velocity and shear–stress coefficient profiles are constructed which satisfy prescribed physical boundary conditions and are plausibly supported by the available experimental data. Author

N67-39500# Johns Hopkins Univ., Baltimore, Md. Dept. of Mechanics.
A PHENOMENOLOGICAL THEORY OF QUASI-PARALLEL TURBULENT SHEAR FLOWS Interim Technical Report
Victor W. Nee and Leslie S. G. Kovasznay Jul. 1967 107 p refs
(Contract DA-31-124-ARO(D)-313)
(AROD-5413-2-e; Rept.-1; AD-657602)

Mean velocity and mean shear stress distributions of two-dimensional quasi-parallel turbulent shear flows are calculated using the assumption that the effective turbulent viscosity obeys a rate equation. The effects of generation, convection, diffusion and decay are each represented by the appropriate terms in that rate equation. Thus, together with the equation of motion, they form a closed system for the two dependent variables; the effective viscosity and the mean velocity. For a newly homogeneous domain, Prandtls mixing length theory can be shown to be a limiting case. Solutions were obtained for the case of the turbulent non-turbulent interface at the outer edge of the boundary layer. Finally, similarity solutions for the incompressible turbulent boundary layers with zero pressure gradient were calculated, assuming the linear growth of the turbulent boundary layer thickness with an additional simple assumption concerning the approximation of the convection terms. The resulting system of non-linear ordinary differential equations were integrated by the use of an analogue computer. The calculated distributions of the mean velocity, total shear stress and turbulent viscosity were compared with experiments. Author (TAB)

N67-39506* Scientific Translation Service, La Canada, Calif.
EFFECT OF RADIATION ON FLOW NEAR THE STAGNATION POINT [O VLIYANII IZLUCHENIYA NA TECHENIYE V OBLASTI KRITICHESKOY TOCHKI]
V. K. Vertushkin and V. N. Zhigulev Washington, NASA, Oct. 1967 4 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Mekhan. Zhidkosti i Gaza (USSR), no. 2, Mar.–Apr. 1967 p 30–32
(Contract NASw-1496)
(NASA-TT-F-11274) CSCL 20D

The hypersonic flow past a blunt body with allowance for radiative transfer effects is discussed, based on an analysis of Goulard's integral differential equation describing the flow of a radiative gas near the stagnation point. It is shown that Goulard's method of treating the gas absorption by expanding the integrand into a Taylor series in the vicinity of its local value does not make it possible to obtain a physically acceptable solution at the body. Asymptotic and numerical solutions are obtained and shown to describe the real nature of the energy balance of a particle of a radiative and absorbing gas at the zero streamline. Author

N67-39507* National Aeronautics and Space Administration, Washington, D. C.

INTERMITTENCY DISTRIBUTIONS IN TURBULENT WALL BOUNDARY LAYERS WITH AND WITHOUT PRESSURE GRADIENTS [INTERMITTENZVERTEILUNGEN BEI TURBULENTEN WANDGRENZSCHICHTEN MIT UND OHNE DRUCKGRADIENTEN]

H. Fiedler Washington, NASA, Oct. 1967 14 p refs Transl. into ENGLISH from Jahr. WGLR (W. Germany), 1965 p 177–184
(NASA-TT-F-11326) CSCL 20D

Intermittency profiles of boundary layers along a wall with various pressure gradients were measured. A function between the parameters ∇ and σ, defining the intermittency and the form parameter H of the velocity profile, is established. The electronic circuit was modified to achieve greater accuracy of measurement. It is shown that in the presence of an adverse pressure gradient the turbulent front shifts farther into the outer region of the boundary layer while the intermittency distribution width becomes smaller. A method for intermittency measuring, using a photoelectric probe with smoke infusion into the boundary layer and illumination through a gap, instead of the conventional hot-wire method for recording turbulence regions, is described. The necessary condition for identity of intermittency of turbulence and concentration is demonstrated. Author

N67-39543# Toronto Univ. (Ontario). Inst. for Aerospace Studies.

AN ANALYSIS OF THE INTERACTION OF A BOUNDARY LAYER AND THE CORNER-EXPANSION WAVE IN SUPERSONIC FLOW Interim Scientific Report

P. H. Oosthuizen Aug. 1967 112 p refs
(Grant AF-AFOSR-365-66)
(UTIAS-TN-117; AFOSR-67-1533; AD-657780)

A theoretical study of the effects of the wall boundary layer on the supersonic flow around a sharp convex corner is presented. Fundamentally different methods of analysis are adopted for laminar and for turbulent boundary layers. In the case of interactions involving laminar boundary layers, an analysis based on the use of classical boundary layer theory is used. Results of numerical calculations carried out using this analysis to predict the effects of the major governing parameters are presented. In all cases, a considerable upstream and downstream influence is predicted. A simplified form of this analysis, closely related to that of Curle, is also presented, this analysis leading to a simple set of explicit equations describing the flow quantities in the interaction region. Comparison of the simplified analysis with results obtained from the full analysis indicated, as is to be expected, that the simplified analysis will only give acceptable results for small expansion angles and moderate Mach numbers. In the case of turbulent boundary layer interactions, an analysis based on the assumption that there is no upstream influence and that the major portion of the expansion occurs in an effectively inviscid manner is adopted, the flow properties being calculated by the method of rotational characteristics. Author (TAB)

N67-39550# Stanford Univ., Calif. Thermosciences Div.

THE INFLUENCE OF ROTATION OF FLOW IN A LONG RECTANGULAR CHANNEL: AN EXPERIMENTAL STUDY

R. M. Halleen and J. P. Johnston May 1967 193 p refs
(Contract AF 49(638)-1278; Grants NSF GP-655; NSF GK-671)
(MD-18; AFOSR-67-2050; AD-658055)

An investigation is reported of the flow regimes and structures in flow through a rectangular channel rotating about an axis perpendicular to the relative velocity vector of the narrow walls of the channel. Flow regimes for the wall layers of the leading and trailing surfaces as functions of the Reynolds Number and a nondimensional rotation parameter are delineated. Flow regime data were obtained primarily from wall-slot dye injection and photography. Mean velocity profiles, wall shear, and reduced pressure across the channel are also given. For no rotation, the flow had a fully developed turbulent mean velocity profile for all cases investigated. As the speed of rotation is increased, important changes in the wall structures, shear, and mean velocity profiles are observed on both walls. Author (TAB)

N67-39568# Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.

UNSTEADY FORCE AND CAVITY CHARACTERISTICS FOR VENTILATED HYDROFOILS

J. M. Wetzel and K. E. Foerster Jun. 1967 46 p refs
(Contract Nonr-710(48))
(Rept.-85; AD-658341)

Experimental measurements were made of the unsteady cavity and force characteristics for both forced and naturally ventilated hydrofoils of finite span submerged below a free surface. Unsteady cavity characteristics were studied for a force-ventilated wedge subjected to a sudden change in either the air flow rate to the cavity or angle of attack. Differences were observed in air entrainment rates measured for the unsteady case as compared to the corresponding instantaneous steady case. The magnitude of the differences depended on the kind of unsteadyness introduced. Unsteady force characteristics were determined for naturally ventilated foils undergoing either a sinusoidal heaving motion or a harmonic oscillation of a trailing edge flap. The amplitude of the oscillatory lift was found to increase with increasing reduced frequency for a heaving foil, whereas the oscillatory lift was essentially constant up to reduced frequencies of 1.2 for the foil with an oscillating flap. There is limited agreement of the data with available theory. Author (TAB)

N67-39597# Aerospace Corp., San Bernadino, Calif.

MERGED LAYER IONIZATION IN THE STAGNATION REGION OF A BLUNT BODY

Richard H. C. Lee and Thomas A. Zierten Jun. 1967 31 p refs
(Contract AF 04(695)-1001)
(TR-1001(S2240-10)-1; SSD-TR-67-149; AD-658859)

Nonequilibrium air dissociation and ionization in the stagnation region of a blunt body are investigated in the merged layer regime. A chemical system of seven species undergoing six simultaneous reactions is considered. The species conservation equations are decoupled from the simplified Navier-Stokes equations for a thin layer model. However, the complex chemical system is allowed to experience the entire merged layer flow environment in a continuous manner from the shock transition region to the viscous shock layer. Solutions are presented for a catalytic blunt body flying at 23,000 fps and at $Re = 814$ and 1230. The results show that viscous effects dominate the entire merged layer and that the air dissociation and ionization are mainly confined to the viscous shock layer with negligible reaction rates in the shock transition region. Comparisons with nonequilibrium inviscid solutions indicate that the inviscid theory overestimates the peak electron density by as much as two orders of magnitude at the lowest Reynolds number considered. This difference between the merged layer solution and the inviscid solution is attributed to a combination of wall cooling and diffusion of atoms and electrons away from the shock layer. Author (TAB)

N67-39600*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EXPERIMENTALLY DETERMINED LOCAL FLOW PROPERTIES AND DRAG COEFFICIENTS FOR A FAMILY OF BLUNT BODIES AT MACH NUMBERS FROM 2.49 TO 4.63

Robert L. Stallings, Jr. Washington, NASA, Oct. 1967 36 p refs

(NASA-TR-R-274) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Drag coefficients and local flow properties were experimentally determined for a family of blunt bodies at Mach numbers from 2.49 to 4.63 at a Reynolds number, based on afterbody diameter, of 1.88×10^6. The family consisted of bodies of revolution having variable nose and shoulder radii (r_n and r_c, respectively) and cylindrical afterbodies 7.5 inches (191 mm) in diameter (d). The geometry of the 18 models tested ranged from a hemisphere-cylinder to a flat-face cylinder. The Mach number effect on nondimensional pressure and velocity distributions of the hemispherical model decreased rapidly with increasing Mach number. These distributions at Mach number 4.63 were essentially the same as previously published results for Mach numbers up to 11.4. Increasing the nose bluntness also decreased the Mach number effect on the pressure and velocity distributions. There was no effect of Mach number on these distributions for the zero-shoulder-radius models for $r_n/d > 0.707$. Drag coefficients determined from integrated pressures over the nose of the hemispherical model and by assuming the base pressure coefficient to correspond to $-1/M_\infty^2$ (where M_∞ is the free-stream Mach number) were in good agreement with previously published data for a sphere. These results were also in good agreement with drag coefficients determined from modified Newtonian theory. Author

N67-39607# Aerospace Corp., El Segundo, Calif.

AXISYMMETRIC HYPERSONIC FLOW WITH STRONG VISCOUS INTERACTION, JULY 1966–JUNE 1967

John Webster Ellinwood and Harold Mirels Jul. 1967 44 p refs

(Contract AF 04(695)-1001)

(TR-1001(2240-10)-11; SSD-TR-67-142; AD-658024)

Stewartsons theory for axisymmetric hypersonic flow of a model gas with strong viscous interaction and strong shock wave is extended to power-law viscosity variation, nonunit Prandtl number, and body shapes other than power laws. For power-law bodies, the generalized theory is obtained in closed form without recourse to numerical integration. In addition, numerical computations are presented for axisymmetric flow over a three-quarter power-law body with strong shock wave and viscous interactions that range from weak to strong. Author (TAB)

N67-39620# RAND Corp., Santa Monica, Calif.

THE LAMINAR-BOUNDARY LAYER WITH LARGE PRESSURE GRADIENT AND SURFACE MASS TRANSFER

C. Forbes Dewey, Jr. and Joseph F. Gross Aug. 1967 32 p refs

(P-3506; AD-657749)

For large values of the pressure-gradient parameter beta (i.e., highly accelerated flows), the order of the similarity equations governing the laminar boundary layer is reduced by two. Coles has shown that this is a singular perturbation problem for which an inner solution and an outer solution must be obtained. In the paper, inner and outer solutions are presented which include the effects of a power-law temperature-viscosity relation, nonunit Prandtl number, leading-edge sweep, and surface mass transfer. An extremely accurate method is described for estimating skin friction and heat transfer for all positive values of beta. Author (TAB)

N67-39637# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.

THEORY OF GAS-SURFACE COLLISIONS

Leon Trilling Dec. 1966 39 p refs

(Contract AF 49(638)-1601)

(FDR-66-7; AFOSR-66-2736; AD-657795)

A theory of gas surface interaction should predict the distribution of molecules re-emitted from a surface in function of the properties of the incident flux and the physics of the surface. It depends on our uncertain knowledge of free-bound heterogeneous molecule interactions and our equally uncertain knowledge of atomic lattice dynamics. The paper critically summarizes and compares with experimental results an increasingly detailed lattice model which gives plausible energy exchange predictions and a geometrical (hard cube) model which shows promise as a correlator of data on scattering direction distribution. Both these models are based on classical interaction mechanisms; some potential generalizations to quantum models are suggested. Author (TAB)

N67-39665# General Electric Co., Schenectady, N. Y. Research and Development Center.

STUDY OF THE SURFACE FILMS OF GAS NUCLEI AS RELATED TO CAVITATION AND TENSILE STRENGTH IN WATER. PART III: DISSOLVING OF GAS NUCLEI IN TURBULENT FLOW

L. H. Bernd May 1967 89 p refs

(Contract Nonr-4296(00))

(S-67-1138; AD-658517)

The paper is a report of an experimental investigation of the dissolving of gas nuclei (small gas bubbles) in turbulently flowing water in a pipe. The rate of dissolving is important in a circulating water tunnel because it determines whether or not cavitation produced nuclei reach a small size to produce tensile strength in the water, increase the cavitation inception level, and affect the results of a cavitation test. The rate of dissolving is greatly affected by the presence of surface films that form about gas nuclei from trace organic materials dissolved in the water. Author (TAB)

N67-39671* Heat Technology Lab., Inc., Huntsville, Ala.

TURBULENT MIXING OF THREE CONCENTRIC REACTING JETS, VOLUME IV Final Report

29 Sep. 1967 98 p refs

(Contract NAS8-11850)

(NASA-CR-89619; HTL-TR-41, Vol. IV) CFSTI: $3.00 CSCL 20D

The results of a computer program based on a modified P-function solution to the multiple-stream-turbulent-mixing problem are presented in graphical form. Though a computational problem persists in the determination of the absolute magnitude of the temperature, the plots of the normalized properties indicate that the trends of the mixing and combustion processes are properly defined. Recommendations to solve the computational problem in the temperature evaluation and to improve the program are outlined. It is concluded with the addition of a recommended subroutine the program would provide a method of describing mixing of equilibrium gases with greater speed than the available programs involving non-equilibrium calculations. Complete listings of the two-stream-mixing program and the three-stream-mixing program are presented. Author

N67-39713# Aerospace Corp., El Segundo, Calif. Lab. Operations.

RESTRICTED VARIATIONAL PRINCIPLE METHOD FOR THE PREDICTION OF LOW-DENSITY TRANSITIONAL REGIME CONE DRAG

Charles R. Ortloff Jun. 1967 32 p refs

(Contract AF 04(695)-1001)

(TR-1001(2240-20)-19; SSD-TR-67-134; AD-657767)

Rosens restricted variational principle representation of the Boltzmann equation was applied to the problem of determining the transitional regime low-density hypersonic flow over slender conical vehicles with diffusely reflecting surfaces. By means of a suitable choice of a trial distribution function, the Euler-Lagrange equations derived from Rosens functional result in a semilinear hyperbolic system amenable to solution by classical characteristics methods. Sample calculations are given and compared with the low-density cone flow experiments of Hickman for assessment of the accuracy of the method presented. It is believed that this method constitutes the first solution method for boundary value problems in the low-density transitional flow regime. Author (TAB)

N67-39736# Air Force Systems Command, Wright-Patterson AFB, Ohio. Aerospace Research Labs.

ON AN ALTERNATIVE METHOD OF NUMERICALLY EVALUATING THE LINEARIZED PROBLEM OF AN IMPULSIVELY MOVING FLAT PLATE IN A RAREFIED GAS FLOW Final Report

Kanakanahalli S. Nagaraja and James P. Hudson Jun. 1967 18 p refs

(ARL-67-0124; AD-658458)

In the Rayleigh problem formulated according to the BGK kinetic model, the flow field is described by a singular integral equation of the Fredholm type. The singularity appears not only as a limit of integration, but also in the kernel. Since the singularity in the kernel is of the logarithmic type, Lukes weight coefficients for evaluating an integral near a logarithmic singularity are applied to solve the integral equation numerically. The successful evaluation of the integral equation on an IBM 7094 demonstrates the generality of the method. Author (TAB)

N67-39772# Case Inst. of Tech., Cleveland, Ohio. Engineering Div.

THE RAYLEIGH–TAYLOR STABILITY OF CONFINED VISCOUS FLUIDS WITH AN INTERFACE

Richard J. Prutow and Simon Ostrach Jun. 1967 111 p refs

(Grant AF-AFOSR-194-67)

(FTAS/TR-67-23; AFOSR-67-1509; AD-658548)

The paper is concerned with the interfacial stability of two stationary superposed viscous fluids confined within a rigid container and subject to both capillary and gravity forces, the gravitational force being directed from the heavier toward the lighter fluid. The stability of a static equilibrium interface when subject to a small disturbance is first posed as a linear initial boundary value problem and the solution obtained in terms of the normal modes associated with a normal mode analysis. The normal modes problem is then recast as a variational problem for the disturbance growth rates. Two parameters appear, the Bond number, and a viscous parameter. The linearization requires the viscous parameter to be of unit order. Using the method of undetermined functions, an approximate solution of the variational problem is obtained for the particular case of a right circular cylindrical container and a flat interface. The unstable growth rates are calculated and the critical Bond number determined to be 14.67. It is found that the viscous forces stabilize the interface. Author (TAB)

N67-39845# American Meteorological Society, Boston, Mass.

INTERACTION BETWEEN AN INSTRUMENT CAVITY AND A FLOW OF RAREFIED GAS [NEKOTORYE VOPROSY VZAIMODEISTVIIA IZMERITEL' NOI POLOSTI S POTOKOM RAZREZHENNOGO GAZA]

A. I. Ivanovskii Bedford, Mass., AFCRL, Jul. 1967 71 p refs Transl. into ENGLISH from *Tr. Tsentr. Aerolog. Observ.* (Moscow), no. 56, 1964 p 49–96

(Contract AF 19(628)-3880)

(T-R-659; TT-67-62820; AD-658028)

The article concerns problems of the interaction between the cavity of a measuring instrument and a flow of rarefied gas. The admittance of a cylindrical tube is computed both for the instrument at rest and for an axial oncoming flow. The admittance and a number of other characteristics are calculated for a rigid tube with dissociation of the particles at the walls. Formulas are derived for the density of a gas inside moving instruments of the simplest design. Author (TAB)

N67-40060# New York Univ., N. Y. Dept. of Aeronautics and Astronautics.

LECTURES ON TURBULENT FLOW, A COURSE GIVEN BY CARLO FERRARI

Gdalia Kleinstein, comp. Dec. 1966 42 p refs

(Contract Nonr-285(63); Grant AF-AFOSR-1062-66)

(NYU-AA-66-69; AFOSR-67-2166; AD-658483)

The work deals with the nature of turbulent motion. The general equations of turbulent flow are described and the fundamental difficulty inherent in the formulation of the problem is demonstrated. From these equations, some important consequences and information of a general nature are derived and applied to a simple wall turbulence problem. A solution is obtained with the aid of a minimum number of auxiliary hypotheses. The problem is first solved assuming an incompressible fluid and then methods are used to permit the utilization of the incompressible results on compressible flow problems. Some attempts to put turbulence theory on a completely rational basis are explored. Author (TAB)

N67-40071# Naval Ordnance Lab., White Oak, Md.

THE EFFECTS OF WATER VAPOR ON THE ELECTRON DENSITY OF SHOCK HEATED AIR

P. M. Aronson and David Levine 4 Jan. 1967 19 p refs

(NOLTR-67-79; Ballistics Res. Rept.-173; AD-658719)

The electron density and collision frequency of air-water mixtures heated in a reflected shock wave zone were compared with the electron density and collision frequency for dry air similarly conditioned. Amounts of water vapor up to 10 percent have only slight effect on the electron density, and no detectable effect on the measured collision frequency. Author (TAB)

N67-40082*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

A RESONANCE-TUBE IGNITER FOR HYDROGEN-OXYGEN ROCKET ENGINES

E. William Conrad and Albert J. Pavli Washington, NASA, Oct. 1967 10 p refs

(NASA-TM-X-1460) CFSTI: HC$3.00/MF$0.65 CSCL 21B

Resonance tube phenomena have been investigated and optimized with a stoichiometric mixture of gaseous hydrogen and gaseous oxygen. The data show the effect of geometric variables on the temperature attained at the resonance cavity bottom for the insulated and uninsulated cases. The maximum temperature attained (>1100°F (866°K)) was sufficient to ignite the gas mixture and thereby demonstrate the capability of a resonance tube as an igniter. Author

N67-40094# General Electric Co., Philadelphia, Pa. Missile and Space Div.

SOLUTION OF THE TIME-DEPENDENT NAVIER-STOKES EQUATIONS FOR THE FLOW OF DISSOCIATING GAS OVER A CIRCULAR CYLINDER Final Report

Sinclaire M. Scala and Paul Gordon 10 May 1967 67 p refs

(Contract Nonr-4869(00))

(R67SD56)

The authors have extended their work on the time-dependent Navier–Stokes equations to include the effects of diffusion and finite rates of chemical reactions for a nonequilibrium gas mixture. The governing system of nonlinear partial differential equations

utilized includes the conservation of mass, momentum, energy and diffusing species, with temperature dependent transport properties and chemical reaction rates. These equations have been utilized in cylindrical coordinates to calculate the time dependent flow field which is formed when a planar shock wave is accelerated toward the cylinder by a planar piston. For the free stream Reynolds number (31.5) and Mach number (2.2) selected for the sample computations, results are presented for the variation of the radial and tangential components of velocity, the density, the temperature and the mass fraction of nitrogen atoms as a function of position and time. The motion of the sonic surface enveloping the cylinder is also shown. Author

N67-40096# Aeronautical Research Inst. of Sweden, Stockholm.
PRESSURE ON AXISYMMETRIC BASE IN A TRANSONIC OR SUPERSONIC FREE STREAM IN THE PRESENCE OF A JET
M. H. Harries Mar. 1967 33 p refs
(FFA-111) CFSTI: HC $3.00/MF $0.65

A series of tests were carried out on a model fitted with a set of interchangeable nozzles giving base-to-jet diameter ratios of 3, 5, 7 and 9 jet design Mach numbers of 1, 1.5, 2 and 3, at free stream Mach numbers of 0.9, 1.1, 1.5, and 2. Two different boundary layer thicknesses were available. The results are presented and it is shown that for a given value of diameter ratio, base pressure is a function of mass flow, but is independent of the jet Mach number, and some progress is made towards predicting the minimum of base pressure. The unsteady flow was found to occur for one or two of the sonic nozzles (which had zero divergence angle) depending on the external Mach number and the jet total pressure. A set of photographs of the phenomenon is included. The minimum base pressure appears to decrease with increase of free stream Mach number, independently of base-to-jet diameter ratio and probably of nozzle design Mach number; the ratio of jet total pressure to base pressure at minimum base pressure appears to be a constant for any given nozzle. Author

N67-40097*# Wisconsin Univ., Madison.
THE STATISTICAL DESCRIPTION OF A SPRAY IN TERMS OF DROP VELOCITY, SIZE AND POSITION
John Frederick Groeneweg (Ph.D. Thesis) 1967 292 p refs
(NASA-TM-X-52355) CFSTI: HC $3.00/MF $0.65 CSCL 20D

The problem of statistically describing a spray immediately after formation and during subsequent propagation is investigated both theoretically and experimentally. Particular emphasis is placed on the roles of drop velocity and position in the spray in addition to the usual considerations of drop size. The facts that (a) spray formation is a random process which is distributed in space, and (b) each individual drop history is a unique function of its initial conditions and later environment; lead to the hypothesis that immediately after spray formation the droplet variables of velocity, position, and temperature should be considered as statistically distributed along with drop size. An available adaptation of molecular statistical mechanics to the spray problem is presented. Author

N67-40117 Canadian Armament Research and Development Establishment, Valcartier (Quebec).
SPECTROSCOPIC STUDIES AND EXCITATION MECHANISM IN AN RF-EXCITED FREE JET
D. Pleiter Jun. 1967 49 p refs
(CARDE-TR-574/67)

A survey was made over the wavelength range from 2250 to 9000Å of the spectra produced by an RF-excited jet of freely expanding nitrogen. Many band systems, including the weak bands of the nitrogen molecule, were produced in the various flow regions of the jet and anomalies within band structures were observed. When the RF energy was coupled to the region of the jet instead of the throat of the nozzle, it excited a shock barrel which gave indications of a very low rotational temperature and a relatively simple excitation mechanism. A few observations were also made when oxygen and mixtures of oxygen and nitrogen were used. Author

N67-40173# Institute for Defense Analyses, Arlington, Va. Science and Technology Div.
ON THE PROPAGATION OF A WEAK PRESSURE WAVE AT VERY LOW PRESSURE
Joshua Menkes and Julius L. Jackson Sep. 1967 21 p refs
(Contract DAHC15-67-C-0011; ARPA Order 5)
(P-328; IDA/HQ-67-6045; AD-659041)

The propagation of a pressure-step discontinuity in an attenuating and dispersive medium is analyzed in the acoustic approximation. An exact solution is obtained, valid for all times and all distances. Approximate solutions for very short times and asymptotically large times are also presented. The range of validity of these approximations is indicated. The presence of an acoustic precursor signal, demonstrated by the exact solution only, appears to be a novel result. Author (TAB)

N67-40198* Scientific Translation Service, La Canada, Calif.
GENERATION OF TURBULENCE IN A PRESSURE-GRADIENT BOUNDARY LAYER [SULLA GENERAZIONE DELLA TURBOLENZA NELLO STRATO LIMITE CON GRADIENTE DI PRESSIONE]
Ennio Mattioli Washington, NASA, Oct. 1967 43 p refs Transl. into ENGLISH from Math. e Naturali (Leipzig), no. 5, 1966 47 p
(Contract NASw-1496; Grant AF-EOAR-63-98)
(NASA-TT-F-11321) CSCL 20D

An experimental study of the boundary layer of a smooth flat impermeable plate parallel to the flow in an incompressible fluid investigates the effect of the positive pressure gradient on transiton from laminar to turbulent flow. A preliminary study deals with the pressure-gradient tunnel specifically constructed for this research. In four particular situations, the characteristic kinematic magnitudes of the boundary layer have been measured. The velocity fluctuations are represented as a function of time. Several oscilloscopic recordings and a check of the two-dimensionality of the boundary layer in the median plane of the plate are also made. Conclusions are made as to the nature of the transition, the exact determination of the corresponding Reynolds number, the existence of a "disturbed layer" above the conventional boundary layer, the shape parameter, and the ways in which the pressure gradient acts to anticipate transition. Author

N67-40268*# Scientific Translation Service, La Canada, Calif.
INVESTIGATION OF THE BOUNDARY LAYER FOR NATURAL AND INDUCED TURBULENCE IN THE CASE OF A SUPERSONIC FLOW ALONG A SMOOTH PLATE [EXPLORATIONS DE LA COUCHE LIMITE, EN TURBULENCE PROVOQUEE, DANS LE CAS D'UNE PLAQUE PLANE]
Jean-Francois Dorand Washington, NASA, Oct. 1967 3 p Transl. into ENGLISH from Publ. Sci. Tech. (Paris), no. 355, 1959
(Contract NASw-1496)
(NASA-TT-F-11359) CFSTI: HC $3.00/MF $0.65 CSCL 20D

The experimental study of the establishment of turbulence around a flat plate placed in a supersonic stream with Mach number 1.85 is carried out by means of dynamic and thermal investigations of the boundary layer. Then the mechanism of this natural transition is compared with the mechanism of the transition caused by a transverse wire glued on the plate which lies normal to the flow. Author

N67-40278# Hydronautics, Inc., Laurel, Md.
CHOKING OF STRUT-VENTILATED FOIL CAVITIES Final Technical Report

Chaim Elata May 1967 29 p refs
(Contract N00014-66-C-0003)
(TR-605-2; AD-659046)

Presented are the results of an investigation of the choking phenomenon in base vented strut cavities. In practice such base vented struts support a ventilated foil and provide the ventilation air for the foil through the strut cavity. An expression for the rate of air entrainment in ventilated cavities is derived. This expression fits previously reported experimental data except at low cavitation numbers, when free surface- solid boundary- and gravitational effects may become important. The shape of the cavity behind a strut, supporting a strut-ventilated foil, is analyzed. It is shown that the shortest section of the strut cavity is at the free surface, and that its length is controlled by the air flow through it. The choking phenomenon is analyzed by relating the air flow through the strut cavity to the air demand of the foil cavity. From this analysis a choking coefficient is defined. A series of experiments is described in which, for three strut-supported foils, the depth at choking was determined as a function of free stream velocity, angle of attack, and air pressure. Author (TAB)

N67-40321* National Aeronautics and Space Administration, Washington, D. C.
UNSTEADY TRANSONIC FLOW PAST A CORNER [OB OBTEKANI UGLA NESTATSIONARNYM OKOLOZVUKOVYM POTOKOM]
B. I. Zaslavskiy Oct. 1967 5 p refs Transl. into ENGLISH from Zh. Prikl. Mekhan. i Techn. Fiz. (Moscow), no. 1, 1967 p 106–108
(NASA-TT-F-11307) CSCL 20D

An analysis, in transonic approximation, is given of the unsteady flow of a compressible gas created by sudden rupture of a membrane separating a half-space filled with a moving gas from vacuum. The structure of the flow is obtained with the aid of exact particular solutions of the equations for unsteady transonic flows. Author

N67-40385*# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.
SPACE VEHICLE LOW GRAVITY FLUID MECHANICS PROBLEMS AND THE FEASIBILITY OF THEIR EXPERIMENTAL INVESTIGATION
Gordon K. Platt 5 Oct. 1967 77 p refs
(NASA-TM-X-53589) CFSTI: HC$3.00/MF$0.65 CSCL 20D

Liquid motions created within the propellent tanks during vehicle acceleration and persisting into the orbital coast of flight are identified. The magnitudes of the motions are estimated and the capabilities and limitations of various test facilities for their investigation are established. A means of attenuating the liquid motions is suggested. Several types of tests are considered for the investigation of the phenomena. Subscale tests may be performed to study initial transient fluid motions induced by several of the phenomena. Since significant damping would not occur during the subscale tests, it is recommended that rocket vehicles be used for tests of sufficient duration to observe the fluid motions until substantial damping has occurred. Author

N67-40384# Naval Weapons Lab., Dahlgren, Va.
FLOW OF LIQUID THROUGH MULTIPLE ORIFICES
W. G. Soper Sep. 1967 49 p
(T-11/67; AD-658501)

A model is developed for predicting the rate of fluid loss from a closed tank containing an arbitrary number of perforations (orifices). Good agreement with experiment is obtained for the two orifice shapes (circular and rectangular) and the three liquids (water, gasoline, and diesel fuel) which were studied. Results indicate that the graphs and formulas developed will apply to many other orifice shapes and liquids. Author (TAB)

N67-40407 Atomic Weapons Research Establishment, Aldermaston (England).
THE DRAG ON A CIRCULAR CYLINDER IN A SHOCK WAVE
Valerie C. Martin, K. F. Mead, and J. E. Uppard May 1967 33 p refs
(AWRE-O-34/67) HMSO: 6s

This report gives details of the loading of a right circular cylinder by a shock wave. The experiments were performed in a shock tube at 8 and 19 psi shock overpressure. The Reynolds' numbers are in the critical and supercritical regions and the Mach number, for the 19 psi case, is equal to 0.56 where compressibility effects are important. The experimental drag coefficients are compared with wind tunnel data and the loading pattern is discussed in relation to existing experimental and theoretical studies. Author

N67-40428# Deutsche Versuchsanstalt für Luft- und Raumfahrt, Freiburg (West Germany).
CALCULATION OF AXIALLY SYMMETRIC TURBULENT BOUNDARY LAYERS WITH SECONDARY FLOW [BERECHNUNG ROTATIONSSYMMETRISCHER, TURBULENTER GRENZSCHICHTEN MIT SEKUNDAERSTROEMUNG]
F. Ebert Sep. 1967 81 p refs In GERMAN; ENGLISH summary
(DLR-FB-67-56) CFSTI: HC$3.00/MF$0.65

The turbulent boundary layer of axially symmetric flows is being investigated. The calculation method developed is being applied on a vortex classifier and a cyclone separator; it is shown that both cases can be described by the same flow model. The calculation is based on the method of integral conditions for momentum and energy and allows an approximative determination of the boundary layer quantities. The results are given as local boundary layer values i.e. boundary layer thickness, secondary flow parameter, profile shape parameter of the main velocity profile. Integral quantities—e.g. moment of wall friction and radial mass flow—are also computed. The theoretical values of wall friction are compared with experimental results obtained on a vortex classifier: correspondence between theory and experiment is satisfactory. Author

N67-40484 Imperial Coll. of Science and Technology, London (England). Dept. of Mechanical Engineering.
CALCULATION OF COMPRESSIBLE TURBULENT BOUNDARY LAYER ON A FLAT PLATE
S. V. Patankar (Indian Inst. of Tech., Kanpur) Aug. 1967 22 p refs
(TWF/7N/28)

Calculations are presented of the compressible turbulent boundary layer on a flat plate. They have been made by a new, general, accurate and economical procedure. The physical inputs chiefly comprise: (1) a form of the mixing-length hypothesis, and (2) the assumption of a uniform effective Prandtl number. The predictions are compared with available experimental data and empirical correlations; the agreement is satisfactory. It is pointed out that the same method may be expected to give good predictions even in more complex situations. Author

N67-40512*# Arkansas Univ., Little Rock. Dept. of Electronics and Instrumentation.
MEASUREMENT OF THE INTENSITY OF TURBULENCE Status Progress Report, 1 Jul. 1966–30 Jun. 1967
Robert L. Bond 30 Jun. 1967 111 p refs
(Grant NGR-04-001-015)
(NASA-CR-89614) CFSTI: HC$3.00/MF$0.65 CSCL 20D

Experiments were conducted to determine the possibility of extending optical heterodyne measurements to the mapping of spatial velocity distribution in turbulent flow, and eventually to three-dimensional turbulent flow. This involves instantaneous

measurements of both the direction and speed of flow at a given point by making velocity measurements along three axes simultaneously. Consideration is given to the causes of frequency and intensity fluctuations in the distribution function, the size and effect of the scattering volume, and the scattering center properties, as well as certain interactions. One-dimensional scattered radiation is studied relative to data reduction, interpretation, and sampling techniques; emphasis is focused on readout of the data. Experimental work is described with details given on alignment, disc velocity effect on data, location of limiting apertures, frequency spread causes, isofrequency lines, frequency measurement limits, electronic and optical noise, and intensity and signal-to-noise ratio. Data are also included on optical scattering by spherical particles, and on the problem of particle recoil from a focused incident laser beam.
M.G.J.

N67-40531# Army Missile Command, Huntsville, Ala. Army Inertial Guidance and Control Lab.
APPLICATION OF THE HYDRAULIC ANALOGY TO INTERNAL SUBSONIC FLOW
Carl Hugh Warren Jul. 1967 94 p refs
(RG-TR-67-19; AD-658669)

An experimental study was made to determine the quantitative accuracy of the hydraulic analogy when applied to subsonic internal flows such as exist in pure fluid elements. The analogy is based upon the correspondence between density and depth (or pressure and depth squared) when the Mach number and Froude number are equal. Experiments were run in air and in water on geometrically similar nonsymmetrical flow dividers. A factor was used to correct for the difference in apparent specific heat ratios k. (Apparent k = 2 for hydraulic flow, k = 1.4 for air flow.) After this correction was made, the data correlated to within three percent. The Reynolds number for the water flow varied from about 1,500 to 4,000 and, for the air flow, from 17,000 to 100,000. The good correlation, even though some of the water data was taken in apparently laminar flow, indicated that inertial effects predominated over viscous effects. This was because the fluid was essentially at rest before it entered the flow divider. The geometry was characterized by sharp angles and relatively short flow lengths so that convective acceleration and separation zones dominated the flow and established patterns of velocity distribution did not have a chance to completely develop.
Author (TAB)

N67-40636 Adviesbureau der Genie, The Hague (Netherlands).
SYMPOSIUM ON SHOCK TUBES, HELD 12–14 APRIL 1967 AT FREIBURG I BR., GERMANY [SYMPOSIUM BETREFFENDE SCHOKBUIZEN (SHOCK TUBES) GEHOUDEN VAN 12 APRIL TOT 14 APRIL 1967 TE FREIBURG I. BR.]
Kolonel C. Schep Apr. 1967 128 p In DUTCH and some other Foreign Languages Symp. held in Freiburg, 12–14 Apr. 1967
(Rept.-163; TDCK-48937)

This report contains 95 abstracts of papers that were presented at the symposium. The subjects include shock tube applications; gas and plasma dynamics; shock tube measurements, calibration, and spectroscopy; properties of detonation and shock waves; chemical reactions and thermodynamics; combustion of solids and liquids in shock tubes; and ionization phenomena. A list of attendants of the symposium is included.
Transl. by K.W.

N67-40688*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AERODYNAMIC HEATING IN THE VICINITY OF CORNERS AT HYPERSONIC SPEEDS
P. Calvin Stainback and Leonard M. Weinstein Washington, NASA, Nov. 1967 28 p refs
(NASA-TN-D-4130) CFSTI: HC $3.00/MF $0.65 CSCL 01A

A study of hypersonic flow in a corner based on past experimental and theoretical studies and recent experiments has revealed at least three flow phenomena which influence the skin friction and heat transfer in the vicinity of a corner. The mutual interaction of the boundary layers in the corner results in a decrease in the local skin friction and heat transfer very near the corner. A vortex system and reattachment of the boundary layer downstream of shock-induced separation results in an increase in heating outboard of the mutual boundary-layer interaction region. Attempts to correlate the peak laminar heating in the vicinity of a corner and the location of this peak, in terms of local fluid properties, were partly successful for the simple models tested. It was found from limited data that the effect of the corner on the maximum increase in heating was less for a turbulent boundary layer than for a laminar boundary layer.
Author

N67-40696*# IIT Research Inst., Chicago, Ill.
NUMERICAL INVESTIGATION OF UNSTEADY LAMINAR INCOMPRESSIBLE CO-AXIAL BOUNDARY LAYER FLOWS
Urmila Agarwal and T. Paul Torda Washington, NASA, Oct. 1967 133 p refs
(Grant NsG-694)
(NASA-CR-908) CFSTI: HC $3.00/MF $0.65 CSCL 20D

A finite difference method is used to solve the laminar, incompressible, time-dependent boundary layer flow equations and the transient response of laminar confined jet mixing to axial velocity fluctuations superimposed at a jet exit. The nonlinear governing differential equations are approximated by linear finite differential equations, and Karplus' criterion is used to determine the finite step sizes. The distortion of the introduced wave in the resulting motion is the same as that of the superimposed wave; with a Reynolds number at 250 (for jet), 228 (for annulus), and 496 (overall flow), no distortion is observed even for the superimposed oscillations.
Author

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

N67-39387* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ROCKET MEASUREMENTS OF THE E-REGION ELECTRON DENSITY DISTRIBUTION IN THE VICINITY OF THE GEOMAGNETIC EQUATOR
A. C. Aikin and L. J. Blumle Oct. 1967 33 p refs
(NASA-TM-X-55973; X-615-67-498) CSCL 04A

Electron density profiles of the E region in the vicinity of the geomagnetic equator near the Peruvian coast were obtained by six Nike–Apache rockets launched from MSTS Crostan. Four flights occurred approximately at noon when the electrojet current system is at its diurnal peak. The other two were nighttime flights. Instrumentation for the cw propagation and dc probe experiments is mentioned, and details on the data are presented. No sporadic E layer was observed, and extreme variability was found at altitudes above 150 km. The existence of a layer below 150 km at night and supporting a westward flowing current system was established. It is suggested that on certain nights or after midnight, the equatorial E region above 150 km is under F region control. Langmuir probe data gave a saturation current to electron density ratio of 10^{-10} amp cm^3.
N.E.N.

N67-39394*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE AURORAL O_2-DISSOCIATION AND THE INFRARED OH-EMISSION

Kaichi Maeda Oct. 1967 41 p refs Presented at the Birkeland Symp. on Aurora and Magnetic Storms, Sandefjord, Norway, Sep. 1967
(NASA-TM-X-55975; X-641-67-506) CFSTI: HC $3.00/MF $0.65 CSCL 04B

It is shown that the dissociation of molecular oxygen in the polar upper atmosphere caused by auroral particles is accompanied by the increase of ozone in the dissociating layer, contrary to that due to the solar UV-radiation. Since hydrogen–ozone reaction is one of the most effective sources for the atmospheric hydroxyl emission (OH vibrational-rotation band airglow), one would expect an enhancement of the OH-emission, following auroral O_2-dissociation. Present calculations based on the time dependent chemical equations for the hydrogen-oxygen atmosphere indicates, however, that the intensity of OH-infrared emission does not enhance during usual quiet auroras, except in the lower borders of the so-called (purplish-red) Type B auroras. The extension of the Monte Carlo calculation of the electron–diffusion in the upper atmosphere to the case of the atmosphere with constant vertical magnetic field is also presented, indicating a drastic confining effect of the magnetic field on the horizontal spread of the impinging electron flux. Author

N67-39433# Army Cold Regions Research and Engineering Lab., Hanover, N. H.
THE PRESSURE DROP ACROSS CURVED INTERFACES
Philip F. Low Jul. 1967 14 p refs
(CRREL-SR-109; AD-657580)

The analysis of a general mathematical equation derived for the pressure drop across a curved interface indicates a valid result as long as the thickness of the interfacial region is small compared to its radius of curvature. However, if the interfacial region is within the range of surface forces, the value of the interfacial tension to be used in the equation may not be that identified with the interface between corresponding bulk phases. Further, if surface forces influence the phases in question, then it cannot be assumed that capillary rise and other associated phenomena are due only to pressure differences across curved interfaces. Also, it cannot be assumed that the curvature of the air-solution interface is controlled entirely by the shape of the capillary. Author (TAB)

N67-39434# Army Cold Regions Research and Engineering Lab., Hanover, N. H.
PENDULUM STEERING FOR THERMAL PROBES IN GLACIERS
Haldor W. C. Aamot Jul. 1967 11 p refs
(CRREL-SR-116; AD-657581)

Pendulum steering, a new concept of attitude stabilization for thermal probes or coring drills in ice, eliminates instability. The center of support is placed above the center of gravity. A lower and upper hot point produce melt penetration. The ratio of their power levels is the basis for stabilization, which is provided by the automatic control of the heater in the upper hot point. This feature makes possible a single thermal probe design that is suitable for all ice cap temperatures and a wide range of penetration rates (i.e., applied power levels). The simplicity of a thermal probe with pendulum steering suggests availability at modest cost and versatility as a widely applicable tool. Author (TAB)

N67-39454# Pennsylvania State Univ., University Park. Ionosphere Research Lab.
IONOSPHERIC RESEARCH Final Report, 1 Apr. 1964–31 Mar. 1967
Thomas A. Seliga 30 Jun. 1967 43 p refs
(Contract AF 19(628)-4050)
(AFCRL-67-0425; AD-658040)

The Statement of Work for the research to be performed under Contract AF 19(628)-4050 called for research directed toward the investigation of the lower ionosphere. Specific emphasis was placed on the design, conduction and analysis of rocket-borne A. C. conductivity probes and radio wave propagation experiments. These objectives have formed the basis for the studies outlined in this report. As stated in Section I, the present contract has been one of related efforts underway in the Ionosphere Research Laboratory during the period of interest. It is a continuation of Part B of the original contract (AF19(604)-8012), pertaining to D and lower E-region rocket measurements. Following certain introductory material an outline of each investigation performed under the contract is given. These are related to former efforts described in the Final Report for Contract AF 19(604)-8012. The problems outlined fit under the broad categories of electromagnetic theory studies, ionospheric phenomena, ground based and rocket equipment development and the physics of ionospheric formation. A listing of the reports issued and in preparation, paper publications and presentations, and similar matters comprises Section III of the report. A listing of the personnel that were actively employed in this work is given in Section IV. The report is concluded with an Appendix containing the abstracts of Scientific Reports issued by the Laboratory under the support provided by this contract. Author (TAB)

N67-39519# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
MESOSPHERIC OZONE MEASUREMENTS DURING A SOLAR ECLIPSE
Jagir S. Randhawa Jun. 1967 7 p refs
(ECOM-5131; AD-658065)

A rocket-borne ozonesonde has been developed which utilizes the chemiluminescent principle for the measurement of ozone concentration in the upper atmosphere. The sonde is deployed in the mesosphere by a small meteorological rocket (Arcas), and ozone concentration is measured as the instrument descends on a drag parachute. This instrument was flown during and before the total solar eclipse of 12 November 1966, at Tartagal (22 deg 32 min S, 63 deg 50 min W), Argentina, with the cooperation of scientists from that country. Ozone was monitored as the sonde passed through the total eclipse shadow between 60 and 54 km, and registered a higher concentration than the sounding made a day earlier at about the same time. A sudden decrease in the ozone concentration was noticed as the sonde emerged from the shadow of the total eclipse. Ozone concentration at 57 km during total solar eclipse was measured to be 3.7 x 0.001 cm/km as compared to 1.4 x 0.001 cm/km measured a day earlier at the same altitude. No marked effect on the ozone concentration in the upper stratosphere was noted during the partial eclipse conditions under which that region was observed. Author (TAB)

N67-39520# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
A TIDAL EXPERIMENT IN THE EQUATORIAL STRATOSPHERE OVER ASCENSION ISLAND (8S)
Norman J. Beyers and Bruce T. Miers Jun. 1967 10 p refs
(ECOM-5132; AD-658066)

Twenty-four meteorological rocket soundings were made from Ascension Island (7 deg 59 min S, 14 deg 28 min W) on 11-13 April 1966. In contrast to results obtained at White Sands Missile Range, New Mexico, the smoothed wind data did not display a consistent well-defined diurnal oscillation. However, results from the temperature data showed a significant diurnal variation. The time of maximum temperature ranged from 1400 LST at 36 km, to 1000 LST at 48 km, to near 1200 LST at 60 km. The maximum diurnal range was 12C at 44 and 60 km. Temperature results were in general agreement with the White Sands Missile Range data. Author (TAB)

N67-39526# Pittsburgh Univ., Pa. Dept. of Earth and Planetary Sciences.

TECTONIC FEATURES OF THE EARTH'S CRUST AND UPPER MANTLE Final Technical Report

Walter L. Pilant Aug. 1967 43 p refs

(Contract AF 49(638)-1534)

(AFOSR-67-1797; AD-658053)

The report deals primarily with a study of Rayleigh surface waves crossing the continent of North America. From this study, a Rayleigh wave phase velocity map was constructed. Features prominent on this map are the following: a large region of high velocities under the Canadian Shield, a prominent low velocity region generally under the Basin and Range province of the western United States moving towards the east as the period shortens from 51 to 20 seconds, a sharp gradient in phase velocity as one traverses the Northern Rocky Mountain region, an isolated region of higher velocities at the southern end of the Appalachian mountains at 51 and 40 seconds period, a region of lower velocities migrating from west of the St. Lawrence River at a period of 51 seconds, to under the Ohio, Indiana, Kentucky region at a period of 20 seconds, generally higher values of phase velocity on the east coast of North America compared to the west coast. A subsidiary investigation revealed the scattering of long period seismic energy by the velocity gradient under the Rocky Mountains.

Author (TAB)

N67-39548*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ON AURORAL ELECTRONS

David S. Evans Oct. 1967 22 p refs

(NASA-TM-X-55978; X-611-67-515) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The results of rocket studies of the energy spectra of primary auroral electrons are reviewed. Many of these spectra display peaks and discontinuities in the range 3 keV to 12 keV which indicate, very unambiguously, that these electrons were energized by an electric field. Moreover the observations directly demonstrate that these electrons were trapped on closed field lines restricting the electric field to one that is normal to the magnetic field. Further observations, primarily of electrons of greater than 10 keV, show that a second impulsive acceleration process supplements the basic electrostatic mechanism. A beam-plasma instability is suggested as being the cause of this acceleration and certain features of such a process are outlined. Direct evidence is presented that the dynamic acceleration occurs very close to the atmosphere (1000 km altitude). Author

N67-39576 Joint Publications Research Service, Washington, D. C.

THE USEAGE OF NMR FOR DIFFERENTIAL MEASUREMENTS IN THE MAGNETIC FIELD OF THE EARTH

A. V. Melnikov 20 Oct. 1967 17 p refs Transl. into ENGLISH from Yadern. Magnitnyy Rezonans (Leningrad), no. 1, 1965 p 49–63

(JPRS-43048; TT-67-33673) CFSTI: $3.00

The principles of constructing differential beat magnometer circuits are discussed along with certain physical problems encountered in the nuclear magnetic resonance method of differential measurements in the geomagnetic field. R.N.A.

N67-39601# Technische Hochschule Fridericiana, Karlsruhe (West Germany). Geophysikalisches Inst.

INVESTIGATIONS ON THE NONELASTIC BEHAVIOR OF THE UPPER MANTLE Quarterly Progress Report, 1 Nov. 1966–31 Jan. 1967

Stephan Mueller and Karl Fuchs 20 Feb. 1967 25 p refs

(Contract AF 61(052)-861; Proj. Vela)

(AFOSR-67-2077; QPR-6; AD-658047)

The spectrum of seismic body phases radiated from sources within the earths crust is distorted by multiple reflections in the crustal layers. To estimate the crustal distortion crustal transfer functions for P-waves have been computed for sources having a simple radiation pattern in the infinite medium: the buried explosive point source standing for an underground explosion, and the vertical point source acting at the free surface of the crust and standing for an atmospheric explosion. The crustal model is taken from Finland. Radiation patterns have been computed for P-waves in the frequency range from 0 to 0.5 cps. An attempt has been made to separate the effect of the free surface from that of the layered crust in case of the explosive source. The latter effect starts to be noticeable at frequencies above 0.3 cps. Using the model for the upper mantle model in Europe (Lehmann, 1959) the radiation patterns have been transformed into amplitude-distance functions. Implications for the interpretation of experimental amplitude-distance curves of P-waves are discussed.

Author (TAB)

N67-39635*# Stanford Research Inst., Menlo Park, Calif.

RESEARCH RELATED TO MEASUREMENTS OF ATOMIC SPECIES IN THE EARTH'S UPPER ATMOSPHERE Quarterly Report

Bernard J. Wood 1 Sep. 1967 7 p

(Contract NASr-49(30); SRI Proj. 6682)

(NASA-CR-89562; QSR-1) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The theoretical and experimental considerations are briefly presented for investigating the O/O_2 ratios in a pressure environment similar to that of the upper atmosphere at about 200 miles altitude. The design of the vacuum equipment is described and is reported to be nearly completed. The pressure is expected to be 10^{-9} torr or lower, and the adsorption and desorption of gaseous species from the surface of the equipment will be in a dynamic steady state. Expressions are developed for the molecular and atomic oxygen recombination rate. N.E.N.

N67-39640# Travelers Research Center, Inc., Hartford, Conn.

COMPUTER PROGRAM FOR THE FALL AND DISPERSION OF PARTICLES IN THE ATMOSPHERE

K. D. Hage, P. S. Brown, G. Arnason, S. Lazorick, and M. Levitz Apr. 1967 214 p refs Prepared for Sandia Corp., Albuquerque, N. Mex.

(SC-CR-67-2530) CFSTI: HC $3.00/MF $0.65

A computer program was formulated for calculating air concentrations and ground deposits of solid particles of various densities and intermediate diameters (about 3 to 300 microns, density 10) released from instantaneous point or line sources at altitudes up to 90 km. The program was developed for use in aerospace nuclear safety hazards analyses. Complete program specifications, descriptions, and operating instructions are given along with some operating guidelines and aids. Examples of input and output are discussed and illustrated. Author (NSA)

N67-39658*# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.

MICROBURST PHENOMENA. III: AN ASSOCIATION BETWEEN ELECTRON MICROBURSTS AND VLF CHORUS

M. N. Oliven and D. A. Gurnett Sep. 1967 24 p refs

(Grant NGR-16-001-043; Contract Nonr-1509(08))

(NASA-CR-89664; Rept.-67-39) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Observations made with the Injun 3 satellite of precipitating $E_e \geq 40$ keV electron microbursts and of VLF chorus emission have revealed their simultaneous occurrence. Observed electron microbursts are always accompanied by a group of VLF chorus emissions; chorus is not necessarily accompanied by microbursts. The maximum region of microburst occurrence from 0400 ≤ magnetic local time ≤ 1300 and 65° ≤ inveriant latitude ≤ 70° lies well within

the maximum region of chorus emissions from 0300≤magnetic local time ≤1500 and 55°≤invariant latitude ≤75°. It is not generally possible to find a one to one (burst to burst) correspondence between individual electron microbursts and VLF chorus bursts. Author

N67-39788*# Illinois Univ., Urbana. Aeronomy Lab.
STUDIES OF THE EQUATORIAL IONOSPHERE USING ROCKET TECHNIQUES
M. Mukunda Rao 1 Jul. 1967 116 p refs
(Grant NsG-511)
(NASA-CR-89742; Rept.-20) CFSTI: $3.00 CSCL 04A

A rocket radio propagation experiment is described in which the differential absorption and the phase difference between the ordinary and extraordinary magneto-ionic components generated at the ground and received at the rocket were measured. From these measurements and by analyzing the standing wave pattern formed by the interference of direct and reflected waves, the electron densities and the electron collision frequencies of the ionosphere through which the rocket passes were deduced. The system was designed for use at temperate latitudes where the so-called "quasi-longitudinal" approximation of the Appleton–Hartree equation holds. During the NASA Mobile Launch Expedition associated with the International Quiet Sun Year, a rocket carrying this experiment was launched from an aircraft carrier located very close to the magnetic equator. This equatorial experiment necessitated certain changes in the system which are described in detail in this report. Author

N67-39797# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
A REPRESENTATION OF THE ANOMALOUS GRAVITATIONAL FIELD [OB ODNOM PREDSTAVLENII ANOMAL' NOGO GRAVITATSIONNOGO POLYA]
M. A. Aleksidze Aug. 1967 11 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR, Ser. Mat. Fiz. (Moscow), v. 170, no. 4–6, 1966 p 828–830
(ACIC-TC-1295; TT-67-62920; AD-658714)

M. S. Molodenskiy posed the following question: Is it impossible to construct on the surface of the sphere such a system of anomalies which would determine together with the field of the normal earth, the external gravitational field coinciding upon surface S (and consequently also beyond S) with the gravitational field of the real earth. In this article M. S. Molodenskiys problem is solved positively. The proof shown is constructive from the point of view that it is simultaneously the algorithm of the solved problem. Author (TAB)

N67-39800# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
INTERPRETATION OF THE MAGNETIC AND GRAVITATIONAL ANOMALIES ABOVE STRATIFIED BODIES [INTERPRETATSIYA MAGNITNYKH I GRAVITATSIONNYKH ANOMALIY NAD PLASTOOBRAZNYMI TELAMI]
A. A. Yun'kov Jul. 1967 53 p refs Transl. into ENGLISH from Gos. Nauchn.-Tekhn. Izd. Lit. po Geol. i Okhrane Nedr (Moscow), 1963 39 p
(ACIC-TC-1245; TT-67-62622; AD-656995)

In order to minimize the difficulty of estimating magnetic and gravitational anomalies widely distributed in the upper part of the earths crust, and to lessen difficulty of determining the parameters of the perturbing bodies, it has been accepted to compare the anomalies above stratified bodies to the anomalies above inclined layers (a body limited by two inclined and one horizontal plane). This makes it possible to study the characteristics of the anomalies and find the necessary method for the determination of the parameters of the perturbing body. In this study it is suggested that the graphic method be used for determining all the parameters of the inclined layer. For this purpose, log-log graticules, compiled for a sufficiently wide change of dimensions of the body under discussion, is recommended. Author (TAB)

N67-39809 Weather Wing (67th), L. G. Hanscom Field, Mass.
THE NEED FOR OBJECTIVE OBSERVING AND REPORTING OF SOLAR FLARES
Hans J. E. Fischer *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 83–91 refs (See N67-39802 24-20)

The paper discusses errors and their sources in the historical solar flare records covering the period from 1955 to 1964. The major sources of error are: (1) inconsistent and frequently changed reporting formats submitted by individual observatories to world data centers, (2) a variety of different units of measure, (3) redundant information in flare reports, and (4) the present practice requiring observers to perform unnecessary computations on raw data. A flare report format is suggested to minimize errors stemming from handling of the data before it is published. Author

N67-39815 California Univ., Berkeley.
THE IONIZATION IN POLAR LATITUDES
Charles F. Power and Charles M. Rush *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 146–155 refs (See N67-39802 24-20)

Analytical data are presented on the results of over 15,000 ionograms obtained during 302 transits of the Alouette I satellite across the Western Hemisphere. These data were obtained from topside soundings taken at high geomagnetic latitudes. Meridional cross-sections of the topside ionosphere were constructed from the height-versus-electron density profiles deduced from the ionograms. Similar cross sections displaying constant plasma frequency as a function of height and geographic latitude were constructed for some transits during geomagnetically quiet periods. Emphasis is centered on the high latitude enhancement in ionization near the magnetic poles. It was found that such sounders provide an excellent means of obtaining detailed synoptic information concerning vertical and meridional distributions of electron densities at F_2 altitudes and above. Information on maximum usable frequencies, ionospheric tilts, and irregularities in electron density distribution can also be determined for radio communication purposes from cross-sectional snapshots of the ionosphere. M.G.J.

N67-39816 Weather Wing (4th), Ent AFB, Colo.
THE COMPUTATION OF ATMOSPHERIC DENSITIES USING SPACE DEFENSE CENTER DATA
Robert E. de Michaels *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 156–159 refs (See N67-39802 24-20)

The observational and orbital element data furnished by the Space Defense Center are listed, and details are given on two specific programs used to determine atmospheric densities. The satellite analysis monitor (SAM) program computes these densities from satellite observations by (1) obtaining orbital elements through differential orbital correction procedures; (2) representing satellite motion over extended time periods by least-squares fitting of orbital parameters using empirical expressions; (3) analyzing the residuals in the mean anomaly; (4) computing the rate of change of the anomalistic period; and (5) deriving atmospheric density by an integration of Sterne's equation. An array of 154 variable parameters is used to control the various sections of the program. The numerical integration procedure (NIP) uses observations covering a two or three day period for satellites having perigee heights less than 200 km. The NIP uses the same observation data as SAM. However, there are several changes in the orbital element input, the primary one being the inclusion of the nighttime exospheric temperature. M.G.J.

N67-39821 Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.
SHORT-TERM PREDICTION OF F2-LAYER MAXIMUM USABLE FREQUENCIES FROM LOCAL MAGNETIC ACTIVITY

R. M. Davis, Jr. *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 209–211 refs (See N67-39802 24-20)

This paper describes and evaluates a method of predicting the maximum usable frequency (MUF) that can be supported by the F2 layer of the ionosphere in a given location at a given time. The information used is a measured value of the K-index in that location, and the prediction is made in terms of the percentage ratio ("percentage-MUF") that the predicted MUF bears to the monthly median MUF, available on a regular basis from various agencies. The prediction is designed to cover a three hour local-time period, which may begin from 0 to 12 hours after the prediction is made, at the option of the user. The method is based on computing the linear regression of the percentage-MUF on the appropriate K-index for general conditions of location and time. Author

N67-39822 Environmental Science Services Administration, Miami, Fla. National Hurricane Research Lab.

PREDICTION OF HURRICANE MOVEMENT

Banner I. Miller and R. Cecil Gentry *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 215–223 refs (See N67-39802 24-20)

Efforts directed toward the improvement of the statistical methods and to develop an improved dynamical model for hurricane prediction are discussed. Initial data requirements for both models are reviewed. There are reasons to believe that a similar statistical forecasting technique can be developed for the Pacific. Efficient utilization of such a tool, however, would probably be dependent on development of operational objective analysis procedures for the Pacific on such a time scale that the hurricane forecasts could be made within 2 to 4 hours after the data were observed. Author

N67-39828 Air Force Cambridge Research Labs., Bedford, Mass.

AN EMPIRICAL STUDY OF LOW-LEVEL SOUNDING PREDICTION

Carl W. Kreitzberg *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 262–275 refs (See N67-39802 24-20)

A pilot study was performed to assess the variability and predictability of low-level soundings (0.5 to 2.0 km) for time scales of 1.5 and 3 hours and a space scale of 100 km. The data used were from Project Stormy Spring mesoscale rawinsonde network for a 27-hour period during passage of an occlusion of moderate intensity. Parameters examined include: temperature and lapse rate; wind direction, speed, shear and geostrophic and ageostrophic components; humidity; geopotential height; and static energy. The signal to noise ratios vary from 2 to 15 depending on the parameter. Trend prediction is of little value, except for height prediction. Horizontal advection has predictive value. Using a higher steering level at about 700 mb yields a substantial improvement for advection of low-level gradients. Wind shear change has a high signal to noise ratio but it is not well predicted by trend or advection. These shears are largely made up of ageostrophic components and the ageostrophic wind profiles change systematically as the storm passes over the network. Net accelerations and eddy viscous forces have magnitudes comparable to the ageostrophic accelerations. Author

N67-39828 Army Cold Regions Research and Engineering Lab., Hanover, N. H.

SURFACE OBSERVATIONS OF SNOW AND ICE FOR CORRELATION WITH REMOTELY COLLECTED DATA

Michael Bilello *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 285–293 refs (See N67-39802 24-20)

Details are given on a network of stations in North America where observations on the properties of snow and thickness of ice are being made. Results of studies using the data collected from these stations show that despite areal and yearly variations definite patterns in the magnitudes of the values emerge when plotted on small scale maps. Aerial infrared and passive microwave systems are being studied for separating clouds from snow covered terrain and penetrating clouds to obtain snow and ice data. The Nimbus II high resolution infrared radiometer pictures, taken at midnight, showed the Gulf Stream in the Atlantic Ocean by differentiating colder and warmer surface water temperatures. A method of determining the temperatures of rivers through the use of narrow-angle radiation measuring devices installed in satellites has also been investigated. Estimates of the heights of drifted snow accumulations and rafted ice can be determined by photogrammetric methods. Author

N67-39836*# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.

MICROBURST PHENOMENA. I: AURORAL ZONE X-RAYS

D. Venkatesan (Calgary Univ.), M. N. Oliven, P. J. Edwards (Southwest Center for Advanced Studies), K. G. McCracken (Southwest Center for Advanced Studies), and M. Steinbock (Southwest Center for Advanced Studies) Sep. 1967 36 p refs (Contracts NASr-198; Nonr-1509(06); Grant NRC A-3865) (NASA-CR-89590; Rept.-67-18) CFSTI: HC $3.00/MF $0.65 CSCL 04A

High time resolution X-ray equipment flown from Ft. Churchill, Manitoba, Canada on August 11, 1965 provides evidence for species of auroral zone X-ray microbursts with an asymmetric time profile. These asymmetric microbursts are characterized by a rise of the form $I \sim 3^{-t/\tau_R}$ where τ_R is about 30 milliseconds, and a decay of the form of e^{-t/τ_D} where τ_D is about 200 milliseconds, and a typical peak flux for the largest events of J_0 ($E_{X\text{-ray}} > 60$ keV) $\approx 10^2$ photons cm^{-2} sec^{-1} at 10 g/cm^2. An episode of these asymmetric bursts was observed in the early morning hours (after 4:30 local time) and an episode of the more common symmetric microbursts began after 9:30 local time. The fast rise times, and the lack of dispersion $\geq$ 10 milliseconds in the X-ray bursts observed at different energies implies restrictions on the nature, and propagation of the parent electron microbursts. Author

N67-39848*# Northwestern Univ., Evanston, Ill.

THE GEOLOGY OF THE LOWER PRECAMBRIAN ROCKS OF THE CHAMPION-REPUBLIC AREA OF UPPER MICHIGAN

W. E. Gordon Taylor 16 Oct. 1967 37 p refs (Grant NGR-14-007-027) (NASA-CR-89604; Rept.-13) CFSTI: HC $3.00/MF $0.65 CSCL 08G

New data and information are presented regarding the lithologies and structure of the Lower Precambrian rocks of the Champion-Republic area of upper Michigan. A series of migmatitic rocks has been involved in several deformational episodes and intruded by two major types of granite and by a suite of amphibolitic dykes. The structural evidence suggests that the earlier Michigamme River granite was emplaced as a sheet during the later stages of the second phase of deformation. The later Amik Lake granite was probably emplaced during a phase of nondeformation. Evidence is given which suggests that both the Middle Precambrian (Animikie) and the Lower Precambrian rocks were involved in the third phase of deformation. Author

N67-39889# Northeastern Univ., Boston, Mass.

STUDIES OF AIRGLOW AND AURORA PHENOMENA USING INSTRUMENTATION TECHNIQUES Final Report, 16 Dec. 1963–28 Feb. 1967

Louis J. Nardone 31 Mar. 1967 42 p refs (Contract AF 19(628)-3876) (AFCRL-67-0431; AD-658468)

In support of the upper-atmosphere research program, work was conducted on the design, construction and testing of instrumentation for the study of airglow and aurora phenomena

Summary descriptions are given of work performed by rocket instrumentation, ground-based equipment and instruments aboard high-flying aircraft. References are made to indicate where the material is published. Summaries are also presented of papers being prepared on interferometric studies of the lambda 5577A emission temperatures in aurora and of the lambda 10830A helium emission layer in the upper atmosphere. A third paper describes initial work performed on the theory of the F layer. Author (TAB)

N67-39890# United States Lake Survey, Detroit, Mich.
TOTAL ATMOSPHERIC WATER VAPOR ALOFT OVER THE GREAT LAKES BASIN
S. J. Bolsenga Apr. 1967 16 p refs
(RR-5-3; AD-658228)

Monthly isoline charts (January-December) are used to indicate the total atmospheric water vapor distribution over the Great Lakes. Empirical equations were derived relating surface dew point to water vapor aloft using observations at three radiosonde stations in the basin. The isoline charts were constructed from data obtained at the three radiosonde stations supplemented by additional values estimated from the equations at 29 stations reporting only surface dew point. Author (TAB)

N67-39897 Joint Publications Research Service, Washington, D. C.
RADIO-WAVE EFFECT ON THE IONOSPHERE IN THE F-LAYER REGION
A. V. Gurevich 27 Oct. 1967 15 p refs Transl. into ENGLISH from Geomagnetizm i Aeronomiya (Moscow), v. 7, no. 2, 1967 p 291–299
(JPRS-43151; TT-67-33776) CFSTI: $3.00

Ionospheric disturbances caused by a directed beam of radio waves emanating from the earth are discussed. It is shown that for an averaged radiation power of an equivalent dipole of $W \geq 5 \cdot 10^4$–10^5 kW the F-layer of the ionosphere seemingly is penetrated by the radio waves. The critical frequency of the F-layer at the same time decreases considerably and the configuration of the surfaces N = const is greatly distorted. Author

N67-39916*# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.
MICROBURST PHENOMENA. AURORAL ZONE ELECTRONS
M. N. Oliven, D. Venkatesan (Calgary Univ.), and K. G. McCracken (Southwest Center for Advanced Studies, Dallas) Sep. 1967 31 p refs
(Contracts NASr-198; Nonr-1509(06); NRC A-3865)
(NASA-CR-89564; Rept.-67-19) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Observations made during a high-time resolution mode of operation of the Injun 3 satellite have identified auroral zone electron microbursts, the parent phenomenon of the often observed bremsstrahlung x-ray microbursts. These electron microbursts, detected in the $E_e \geq 40$ keV (180°) (precipitating) detector and less frequently in the $E_e \geq 40$ keV (90°) (trapped) detector, have time profiles similar to those of both the symmetric and asymmetric daughter X-ray microbursts and exhibit typical peak fluxes of J_e ($E_e \geq 40$ keV) $\approx 3 \times 10^5$ electrons cm^{-2} sec^{-1} $sterad^{-1}$ in the 180° detector. Statistical studies of these satellite-observed microbursts reveal their occurrence predominantly in the regions of $6 \leq L \leq 8.5$ and 4:30 ≤ magnetic local time ≤ 12:30. Detailed statistical distributions of microbust occurrence as functions of local time and L are presented. Author

N67-39924*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE OBSERVATION OF A NEAR MONOENERGETIC FLUX OF AURORAL ELECTRONS
D. S. Evans Sep. 1967 27 p refs
(NASA-TM-X-55971; X-611-67-487) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Rocket borne observations were made of a nearly monoenergetic beam of electrons in association with a pre-breakup auroral display. The characteristic energy of this beam was about 4 KeV and was very stable over a 150 second period of time. The nature of this energy spectra strongly suggests that the electron energization was by the electric fields associated with some static 4 KeV potential difference in the magnetosphere. A model in which this potential was established directly along a magnetic field line cannot be uniquely excluded by these observations but is discounted on other grounds. The alternative is a model in which the required electric field is transverse to the magnetic field lines. Such electric fields are known to exist and have been measured directly. Energization of low energy electrons by an electric field of this geometry would appear to require that these electrons be stably trapped on closed lines of magnetic force, the energization occurring by virtue of gradient and line curvature drift across equipotential lines. The electrical potential differences known to be available in the magnetosphere although sufficient to produce these 4 KeV electrons are inadequate to produce the 100 KeV electrons seen in association with the aurora. Thus the existence of at least two acceleration mechanisms is firmly established. Author

N67-39949# Stanford Univ., Calif. Radioscience Lab.
AN INTEGRATED METEOR RADAR SYSTEM FOR WIND AND DENSITY MEASUREMENTS IN THE UPPER ATMOSPHERE Final Report, 1 Mar. 1964–28 Feb. 1967
Robert Nowak May 1967 148 p refs
(Contract AF 19(628)-3996)
(SEL-67-046; AFCRL-67-0347; AD-658463)

The theory of radio reflection from meteor trails is reviewed, and, based on its predictions, the specifications for a multiparameter meteor radar are derived. The synthesis of a completely integrated, coherent pulse radar is described; with this radar, echo strength, range, elevation angle, and Doppler shift of the signals reflected from trails can be measured. The main features of this system are digital recording and processing of the data; the use of a composite signal waveform that permits simultaneous measurement of range, amplitude, and Doppler at low peak power; and the recording of both amplitude and sign of the Doppler shift in one channel. Data are processed automatically; the radar station is inexpensive and reliable enough to provide the basis for multistation synoptic measurements of upper atmospheric winds. The performance of the system is analyzed and measurements with three antenna arrangements are described. Echo heights are determined directly at high elevation angles from range and angle of arrival. It is shown that the height of reflection can be related to the amplitude decay of a certain class of echoes. If these echoes are selected properly (a procedure for this selection is given) and if a daily variation of the decay/height relationship is taken into account, height can be estimated from signal decay to within plus or minus 1 km. At low elevation angles, winds are measured from the Doppler shift of the trail echoes and their height is determined from the amplitude decay, using the relationship between them that was previously established. With theoretical relationships, atmospheric density can be estimated directly from the echo decay. Wind measurements made in April 1967 show prevailing winds that are predominantly zonal, as well as strong periodic wind components with periods of 24 and 12 hours. Author (TAB)

N67-39964# Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.
RADIO SCIENCE, VOLUME 2, NUMBER 10
D. D. Crombie, ed. Oct. 1967 159 p refs Prepared in cooperation with Natl. Comm. of the Intern. Sci. Radio Union
GPO: $1.00

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N67-39965# Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.

REVIEW OF CURRENT METHODS FOR OBTAINING ELECTRON-DENSITY PROFILES FROM IONOGRAMS

J. W. Wright and G. H. Smith *In its* Radio Sci., Vol. 2, No. 10 Oct. 1967 7 p (See N67-39964 24-13)

Certain aspects of the general ionogram analysis problem, common to most methods of attack, are discussed as an introduction to the papers of this series. Present attainable accuracies and criteria affecting the choice of method for typical problems are discussed. This paper contains, in part, results of discussions of the URSI–CIG Subcommittee on *N(h)* profiles held at its meeting in London, May 1964. Author

N67-39966# Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.

IONOSPHERIC ELECTRON-DENSITY PROFILES WITH CONTINUOUS GRADIENTS AND UNDERLYING IONIZATION CORRECTIONS. I: THE MATHEMATICAL–PHYSICAL PROBLEMS OF REAL-HEIGHT DETERMINATION FROM IONOGRAMS

Adolf K. Paul *In its* Radio Sci., Vol. 2, No. 10 Oct. 1967 7 p (See N67-39964 24-13)
(NASA Order R-126)

Any numerical method for inversion of the integral equation must satisfy certain requirements in order to avoid introducing features into the true-height profile which are not indicated by the ionogram. These requirements are first investigated by considering the equation as an integral transformation of $f_n(z)$ for several model distributions. In order to satisfy the above-mentioned criteria a second-order lamination process was developed; its mathematical principles are presented in this paper and its implementation at the Institute for Telecommunication Sciences and Aeronomy is discussed in the two following papers. Author

N67-39967# Environmental Sciences Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.

IONOSPHERIC ELECTRON-DENSITY PROFILES WITH CONTINUOUS GRADIENTS AND UNDERLYING IONIZATION CORRECTIONS. II: FORMULATION FOR A DIGITAL COMPUTER

H. Herbert Howe and Dean E. Mc Kinnis *In its* Radio Sci., Vol. 2, No. 10 Oct. 1967 24 p (See N67-39964 24-13)
(NASA Order R-126)

Details are given of a practical computer formulation of the solution to the ionogram real-height problem developed at the Institute for Telecommunication Sciences and Aeronomy (ITSA) by A. K. Paul. The method can make full joint or independent use of the ordinary and extraordinary group-height information available from modern high-quality radio soundings of the ionosphere. It takes advantage of the strong dependence of group height on the vertical electron-density gradient at the reflection level to provide a profile with continuous gradients; this is an important feature when applying profile data to radio ray tracing or certain aeronomical problems. Corrections for the "starting" and "valley" portions of the distribution (not directly observed on the soundings) are made by fitting simple models for these regions to portions of the ordinary and/or extraordinary echo data. The problem of numerical convergence of integrals involving the group refractive index infinity is solved by a new expression for the index in which the singular part can be integrated explicitly. The layer maximum is obtained by a parabolic extrapolation which maintains the continuity of gradient to the layer peak and which does not require an independent estimate of the critical frequency. Author

N67-39968# Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.

IONOSPHERIC ELECTRON-DENSITY PROFILES WITH CONTINUOUS GRADIENTS AND UNDERLYING IONIZATION CORRECTIONS. III: PRACTICAL PROCEDURES AND SOME INSTRUCTIVE EXAMPLES

J. W. Wright *In its* Radio Sci., Vol. 2, No. 10 Oct. 1967 10 p (See N67-39964 24-13)
(NASA Order R-126)

A description is given of procedures developed at the Institute for Telecommunication Sciences and Aeronomy (ITSA) to permit accurate extraction of virtual-height data from ionograms in a form easily usable by digital computers. Criteria are described for identification of the significant interval limits along ionogram echo traces. Author

N67-39969# Auckland Univ. (New Zealand). Radio Science Centre.

THE OVERLAPPING-POLYNOMIAL ANALYSIS OF IONOGRAMS

J. E. Titheridge *In* Environ. Sci. Serv. Admin. Radio Sci., Vol. 2, No. 10 Oct. 1967 7 p (See N67-39964 24-13)

A simple and more direct derivation of the equations used in the overlapping-polynomial analysis of ionograms is given. A set of five simultaneous equations is obtained which define the five polynomial coefficients required at each frequency. The steps involved in programming a computer to calculate these coefficients

and analyze a virtual-height record are outlined. The calculation of the coefficients takes about 40 percent longer than the calculation of the coefficients for a lamination analysis using the same number of points. Since, however, the polynomial method requires only about one quarter as many points as a lamination analysis for a given accuracy, a considerable saving is achieved both in the time required for measuring the virtual heights and in the computer time required for calculating the coefficients and analyzing the records. A procedure for allowing for the presence of ionization below the nighttime F layer is also described; this includes corrections for both the low-density ionization in the E region and the finite ionization gradient at the bottom of the F layer. Author

N67-39970# Japan Broadcasting Corp., Tokyo. Radio Research Labs.

DIRECT USE OF THE PHASE REFRACTIVE INDEX FOR REDUCING H'(F) CURVES TO N(H) PROFILES

H. Hojo *In* Environ. Sci. Serv. Admin. Radio Sci., Vol. 2, No. 10 Oct. 1967 17 p (See N67-39964 24-13)

A method for obtaining N(h) profiles from h'(f) curves by the direct use of the phase refractive indices is developed for both the ordinary and extraordinary modes. The method is extended for solving the starting problem by the joint use of ordinary and extraordinary h'(f) curves and by assuming the Chebyshev expansion regarding the profile below f_{min}. It is pointed out that the phase height at f_{min} is useful for obtaining an accurate profile above f_{min}. The profile is assumed to be a monotonic function of height, but the method can be extended to include the profile containing a valley. The effect of the earth's magnetic field is included without a height variation, and the method neglects the effect of electron collisions. Author

N67-39971# Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.

USE OF VIRTUAL-HEIGHT SLOPES FOR DETERMINATION OF ELECTRON-DENSITY PROFILES

Adolf K. Paul *In its* Radio Sci., Vol. 2, No. 10 Oct. 1967 10 p (See N67-39964 24-13)

The relationship between the slope of an ionospheric virtual-height curve and the higher derivatives of the *N(h)* profile is derived and discussed. The slope is found to depend mainly on the second-height derivative at the reflection point of the probing wave. A method of ionogram analysis based upon this formulation is proposed. The appendix presents new forms of the phase refractive index and its derivatives. Author

N67-39972# Max-Planck-Institut für Aeronomie, Lindau über Northeim (West Germany). Inst. fuer Ionosphaeren-Physik.

ON THE MANUAL AND DIGITAL COMPUTER METHODS USED AT LINDAU FOR THE CONVERSION OF MULTIFREQUENCY IONOGRAMS TO ELECTRON DENSITY-HEIGHT PROFILES

W. Becker *In* Environ. Sci. Serv. Admin. Radio Sci., Vol. 2, No. 10 Oct. 1967 28 p (See N67-39964 24-13)

Real-height analysis of multifrequency virtual-height traces at Lindau takes account of underlying ionization and extrapolates peak real-height profiles based on observed virtual heights rather than deduced real heights. At least second order approximations of the profiles are used. A model method is described that requires only 8 min to reduce a simple F trace, and the real-height data obtained have been useful for statistical purposes. Manual methods, in use since 1957, require 1-1/2 hr for full analysis of one ionogram and rely on a visual estimate of the critical frequency of the layer of interest. The digital computer method in use since 1962 finds this value and provides more accurate results than the manually-obtained ionosondes. A complete real-height analysis of one virtual-height trace, with a critical frequency of 16 MHz, requires about 14 min time on the IBM 650 computer. Test results are reported for a series of theoretical ionograms of monotonic and more-or-less nonmonotonic electron density-height profiles and valley profiles. Author

N67-39973# Pennsylvania State Univ., University Park. Ionosphere Research Lab.

TEN-POINT METHOD OF IONOGRAM REDUCTION

E. R. Schmerling *In* Environ. Sci. Serv. Admin. Radio Sci., Vol. 2, No. 10 Oct. 1967 4 p (See N67-39964 24-13)

The "ten-point" manual method of ionogram reduction provides true heights at selected frequencies. The method is especially convenient when only the height of maximum density is required, but it can also be used to obtain the complete profile. A single true height is obtained as the average of ten virtual heights sampled at fixed submultiples of the frequency. The sampling points, which depend on the geomagnetic parameters, may be rapidly selected by using the appropriate transparent overlay. A correction for underlying ionization may be incorporated by reading one virtual height from the extraordinary trace. Author

N67-39974# Auckland Univ. (New Zeland). Radio Research Centre.

DIRECT MANUAL CALCULATIONS OF IONOSPHERIC PARAMETERS USING A SINGLE-POLYNOMIAL ANALYSIS

J. E. Titheridge *In* Environ. Sci. Serv. Admin. Radio Sci., Vol. 2, No. 10 Oct. 1967 17 p (See N67-39964 24-13)
(Grant NsG-54-60)

Two extensions of the basic polynomial analysis are described. Firstly the polynomial representation of the real-height curve is modified to include a parabolic peak; this greatly increases the accuracy of calculations near the peak of the ionospheric layers. Secondly the analytic expression for the real-height curve is used to obtain expressions for the height of the peak (h_m) and the scale height at the peak (H). Integration of the real-height curve also gives an expression for the effective subpeak thickness of the ionosphere (T), defined as the total amount of ionization below the peak divided by the density at the peak. These three expressions are then used to obtain coefficients relating h_m, H, and T to the virtual heights at any required frequencies. Author

N67-39975# Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.

COMPUTATION AND APPLICATION OF SYNOPTIC IONOSPHERIC PROFILES

A. R. Laird and J. W. Wright *In its* Radio Sci., Vol. 2, No. 10 Oct. 1967 7 p (See N67-39964 24-13)
(NASA Order R-126)

Results from the Institute for Telecommunication Sciences and Aeronomy (ITSA) synoptic surveys of ionospheric morphology by systematic calculation of large numbers of electron-density profiles are described. Averages of individual hourly profiles provide a quantitative measure of the day-to-day variability of the ionosphere in addition to much information concerning average ionospheric structure. The average profiles can also be obtained from a "composite virtual-height curve" representing all of the observations at a given hour in a month. It is shown that these two ways of obtaining averages are equivalently useful for survey purposes. Observations from five years of profile calculations using both systems illustrate the decrease of F-region electron content, height of peak density, and characteristic thickness with decreasing solar flux in a 12-month running average. Author

N67-39976# Groupe de Recherches Ionospheriques, Paris (France).

A QUICK MODEL METHOD FOR OBTAINING REAL-HEIGHT PARAMETERS FROM ROUTINE IONOSPHERIC DATA

C. Taieb *In* Environ. Sci. Serv. Admin. Radio Sci., Vol. 2, No. 10 5 p (See N67-39964 24-13)

A method is presented by which profile parameters of the *F* region may be obtained from the ionogram measurements systematically collected and published by the world ionosonde network. The graphical procedures allow for the effect of the earth's magnetic field, and correct for underlying layers. Author

N67-39979*# Illinois Univ., Urbana. Aeronomy Lab.
INSTRUMENTATION AND PRELIMINARY RESULTS FROM SHIPBOARD MEASUREMENTS OF VERTICAL INCIDENCE IONOSPHERIC ABSORPTION
George W. Henry, Jr. 1 Oct. 1966 237 p refs *Its* Aeronomy Report No. 13
(Grant NsG-511)
(NASA-CR-89783) CFSTI: HC$3.00/MF$0.65 CSCL 04A

The design of the instrumentation used to measure vertical incidence absorption and partial reflections on board the USNS Croatan aircraft carrier as a portion of the NASA research expedition in 1965 to the southern Pacific Ocean is discussed. Preliminary data reduced from film records is presented. The instrumentation being used for similar measurements at Wallops Island and at the Aeronomy field station near Urbana, Illinois is also presented. Author

N67-40005 Joint Publications Research Service, Washington, D. C.
SOVIET-BLOC RESEARCH IN GEOPHYSICS, ASTRONOMY, AND SPACE NO. 167
3 Nov. 1967 149 p refs Transl. into ENGLISH from the Russian
(JPRS-43221; TT-67-11147-167) CFSTI: $3.00

Research information gathered from recent Sino–Soviet Bloc publications is presented in the form of abstracts, summaries, and occasional full translations of articles dealing with astronomy, meteorology, oceanography, terrestrial geophysics, the upper atmosphere, and space science. Complete bibliographic information accompanies each article. R.N.A.

N67-40021# Stanford Univ., Calif. Dept. of Geophysics.
GEOPHYSICAL STUDY OF BASIN-RANGE STRUCTURE, DIXIE VALLEY REGION, NEVADA Final Scientific Report, Jan. 1964–Dec. 1966
George A. Thompson, Laurent J. Meister, Alan T. Herring, Thomas E. Smith, Dennis B. Burke et al Jul. 1967 297 p refs Sponsored in part by DASA
(Contract AF 19(628)-3867)
(AFCRL-66-848; AD-657326)

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6. SURFACE STRAIN CHANGES AND STRAIN ENERGY RELEASE IN THE DIXIE VALLEY-FAIRVIEW PEAK AREA, NEVADA L. J. Meister, R. O. Burford, G. A. Thompson, and R. L. Kovach 32 p refs (See N67-40027 24-13)
7. SEISMIC REFRACTION STUDY OF SMITH CREEK VALLEY, NEVADA A. T. Herring 16 p refs (See N67-40028 24-13)
8. AEROMAGNETIC SURVEY OF SMITH CREEK VALLEY, NEVADA I. A. Salehi 25 p refs (See N67-40029 24-13)
9. SEISMIC REFRACTION STUDY OF FOURMILE FLAT, NEVADA M. D. Wood 18 p refs (See N67-40030 24-13)

N67-40022# Stanford Univ., Calif. Dept. of Geophysics.
BACKGROUND AND RESULTS
George A. Thompson *In its* Geophys. Study of Basin-Range Struct., Dixie Valley Reg., Nev. Jul. 1967 14 p refs (See N67-40021 24-13)

The subsurface structure and origin of a tectonically active part of the Dixie Valley region basin in Nevada was studied by seismic refraction, gravity measurements, magnetic measurements, aerial photographic mapping, strain analysis of geodetic data, and elevation measurements for its geometric and temporal relations of ridges and rifts. Various relationships of the basin and range systems with the San Andreas fault system in California were observed and a picture of gradual shifting structural deformation over a considerable period of Cenozoic time with persistent sinking of the bedrock floor of the Dixie Valley emerged. G.G.

N67-40023# Stanford Univ., Calif. Dept. of Geophysics.
SEISMIC REFRACTION STUDY OF DIXIE VALLEY, NEVADA, PART I
Laurent J. Meister (Ph.D. Thesis) *In its* Geophys. Study of Basin-Range Struct., Dixie Valley Reg., Nev. Jul. 1967 80 p refs (See N67-40021 24-13)

Seismic refraction studies of Dixie Valley, Nevada, have revealed a buried complex of normal faults which form a long subsurface trough with a "graben in graben" structure. This basin structure indicates that Dixie Valley subsided along a complex system of step faults rather than along single boundary faults. Velocities ranging from 5000 to 8000 ft/sec are associated with unconsolidated to semi-consolidated sediments of Pleistocene and recent age. A seismic velocity boundary below which the velocity increases to an average of 10,000 ft/sec is characteristic of the entire Dixie Valley region; this higher velocity is correlated with volcanic rocks in the upper part of the Miocene to Pleistocene section that partly caps the Stillwater Range to the west. A special study was made of side refractions in a reversed profile parallel to the outcropping fault zone bounding the Stillwater Range west of Humboldt Salt Marsh. The geometric constraints of the fault pattern argue against large scale strike-slip faulting in Dixie Valley, and other geophysical evidence supports an interpretation of primarily dip-slip displacements. The average displacement rate during the life of the basin is on the order of one ft per thousand years. Author

N67-40024# Stanford Univ., Calif. Dept. of Geophysics.
SEISMIC REFRACTION STUDY OF A FAULT ZONE IN DIXIE VALLEY, NEVADA, PART II
Alan T. Herring *In its* Geophys. Study of Basin-Range Struct., Dixie Valley Reg., Nev. Jul. 1967 33 p refs (See N67-40021 24-13)

Seismic refraction was used in Nevada to study the fault zone bounding the alluvium on the west side of Dixie Valley and the crystalline basement on the east side of the Stillwater Range. Seismic refraction profiles utilizing patterns of air charges were successful on the high alluvial fan where, a year previously, charges planted up to a hundred feet below the surface in the dry fan material failed to yield usable refraction records. Profiles were shot parallel to the strike of the fault zone so that a special method of interpreting side refractions had to be derived. The derived technique should be useful in studying faults in the Nevada Basin and Range province or anywhere that similar geometry is suspected. Four normal faults with dips between 55 and 70 degrees were found and delineated. Rather than a single steep drop-off, the faults form a series of steps descending to the deepest part of the valley. Author

N67-40025# Stanford Univ., Calif. Dept. of Geophysics.
AEROMAGNETIC MEASUREMENTS IN DIXIE VALLEY, NEVADA: IMPLICATIONS REGARDING BASIN-RANGE STRUCTURE, PART III
Thomas E. Smith *In its* Geophys. Study of Basin-Range Struct., Dixie Valley Reg., Nev. Jul. 1967 29 p refs (See N67-40021 24-13)

Interpretation of an aeromagnetic survey flown during 1964 suggests that the pre-Tertiary magnetic basement under Dixie Valley, Nevada, forms an asymmetric, composite graben. The deepest component block is approximately 5 km wide and lies under the western half of the valley at an average depth of 2 km. Depth estimates imply, in addition, that the eastern shelf block is broken by several NW-trending transverse faults of 300 to 600 meters displacement. Models computed from anomalies over the southern gabbro contact tend to verify earlier geologic inferences that this intrabasement complex is of lopolithic form. Satisfactory alternative solutions of an equidimensional anomaly in southeastern Dixie Valley are either a volcanic cone or an equidimensional volcanic remnant. Both computational models overlie the gabbroic complex and require a high total magnetization. Author

N67-40026# Stanford Univ., Calif. Dept. of Geophysics.
AERIAL PHOTOGRAPH SURVEY OF DIXIE VALLEY, NEVADA, PART IV
Dennis B. Burke *In its* Geophys. Study of Basin-Range Struct., Dixie Valley Reg., Nev. Jul. 1967 41 p refs (See N67-40021 24-13)

Large scale aerial photographs of Dixie Valley, Nevada record surface features in the alluvium that are associated with bedrock faulting. The photogeologic study reveals a complexity of sub-alluvial structure. Mapping of beach ridges of ancient Dixie Lake supplies a measure of tilting and offset in approximately the last 10,000 years. The pattern of faulting and the geomorphology, together with data from geophysical investigations, indicate that the basin is a complex graben, subsiding along multiple step faults. The graben shallows and pinches out in the northern part of the valley. The structure is less clear in the southern part of the valley but involves a shallowing and possible change in trend of the graben. Pronounced topographic asymmetry of the valley and adjacent ranges is believed to have been caused by slight tilting of the region, commensurate with normal faulting during crustal extension. Author

N67-40027# Stanford Univ., Calif. Dept. of Geophysics.
SURFACE STRAIN CHANGES AND STRAIN ENERGY RELEASE IN THE DIXIE VALLEY–FAIRVIEW PEAK AREA, NEVADA, PART V
Laurent J. Meister, Robert O. Burford, George A. Thompson, and Robert L. Kovach *In its* Geophys. Study of Basin-Range Struct., Dixie Valley Reg., Nev. Jul. 1967 32 p refs (See N67-40021 24-13)

Observations by the United States Coast and Geodetic Survey before and after the 1954 earthquakes in the Dixie Valley–Fairview Peak area have been reduced to surface strain patterns. The strain analysis shows a predominant NW–SE extension in the epicentral areas of the Rainbow Mountain and Fairview Peak earthquakes and NW–SE contraction in adjacent areas. The pattern of strain changes thus conforms to an elastic rebound model. A minimum energy release of 1.3×10^{23} ergs was estimated from the elastic strain changes. This value is comparable to the total energy released by the four large 1954 shocks as approximated by means of the magnitude-energy conversion. Net lowering of the ground surface during the earthquakes indicates a release of gravitational potential energy of about 4.3×10^{23} ergs. This energy possibly was dissipated as a minor, undetected uplift in a broad region surrounding the epicentral area. Author

N67-40028# Stanford Univ., Calif. Dept. of Geophysics.
SEISMIC REFRACTION STUDY OF SMITH CREEK VALLEY, NEVADA, PART VI
Alan T. Herring *In its* Geophys. Study of Basin-Range Struct., Dixie Valley Reg., Nev. Jul. 1967 16 p refs (See N67-40021 24-13)

Three reversed seismic refraction profiles were shot in Smith Creek Valley, Nevada, during September, 1966, to determine the depth and structure of the high-velocity basement. This work complements a gravity survey and an aeromagnetic survey in the same valley. An interpretation of the seismic data exclusive of the gravity and aeromagnetic information indicates that the basement in both Smith Creek Valley and Dixie Valley is similar in structural complexity. The maximum depth to basement in Smith Creek Valley ranges from 6500 ft. to 8000 ft. as compared to 10,000 ft. in Dixie Valley though a greater depth under the playa may be possible. Author

N67-40029# Stanford Univ., Calif. Dept. of Geophysics.
AEROMAGNETIC SURVEY OF SMITH CREEK VALLEY, NEVADA, PART VII
Iraj A. Salehi *In its* Geophys. Study of Basin-Range Struct., Dixie Valley Reg., Nev. Jul. 1967 25 p refs (See N67-40021 24-13)

An airborne magnetometer survey was conducted in Smith Creek Valley, Nevada, in the summer of 1965. The survey strongly indicated a rock body—perhaps a volcanic plug covered by the valley fill—with reverse remanent magnetization. It also indicated the existence of several blocks, in the basement, with normal magnetization. The maximum depth to the basement was found to be approximately 3700 ft. No definite proof of major faulting could be obtained but indications of a major geological boundary, lithological if not structural, were observed along the central part of the valley and parallel to the general structural trend. Author

N67-40030# Stanford Univ., Calif. Dept. of Geophysics.
SEISMIC REFRACTION STUDY OF FOURMILE FLAT, NEVADA, PART VIII
M. Darroll Wood *In its* Geophys. Study of Basin-Range Struct., Dixie Valley Reg., Nev. Jul. 1967 18 p refs (See N67-40021 24-13)

Four reversed seismic refraction profiles were shot west of the Sand Springs Range in the Fourmile Flat area of west central Nevada. Velocities ranging from 18,800 to 15,500 ft/sec are assumed to represent basement, which lies at a maximum depth of 3500 ft. The basement deepens to the southwest. In places, the slope is nearly 13° but flattens toward the south to a maximum depth of 3000 ft with no detectable tendency to shallow near the Cocoon mountain front. Volcanics are possibly indicated by a wedge of 10,600 ft/sec material in the southeast thinning out in the north where the basement is shallow and its slope minimal. A 9300 ft/sec layer with a thickness of 1000 ft overlies the 10,600 ft/sec volcanic wedge and basement. A thin 6700 ft/sec section covers the low velocity volcanics near the playa and is interpreted as clay and silty material. The total thickness of the 6700 ft/sec material ranges from a maximum of 1000 ft nearest the playa to less than 500 ft under more distant profiles. Author

N67-40032# Comissao Nacional de Atividades Espaciais, Sao Jose dos Campos (Brazil). Lab. de Fisica Espacial.
PROCEEDINGS OF THE SECOND INTERNATIONAL SYMPOSIUM ON EQUATORIAL AERONOMY
Fernando de Mendonca, ed. 1965 563 p refs Symp. Held in Sao Jose dos Campos (Brazil), 1965
(AD-658489)

Contents: Papers were given under the following topics: The D-region and lower atmosphere; Absorption in the equatorial ionosphere; The regular E region and equatorial Es; The regular

low latitude F-region; bottom and topside studies; F-region disturbances and irregularities; Ionospheric drifts; Exosphere; Airglow; Low latitude current system including electrojet and magnetic variations; Magnetic and ionospheric storms; Low latitude magnetic pulsations. TAB

N67-40037 Hawaii Univ., Honolulu. Inst. of Geophysics.
MEAN MONTHLY SEA-SURFACE TEMPERATURES OF THE INDIAN OCEAN DURING THE INTERNATIONAL INDIAN OCEAN EXPEDITION
Forrest R. Miller and Charmian Jefferies Jul. 1967 62 p refs
(Grant NSF GA-386)
(HIG-67-14; Rept.-2)

Data on the sea surface temperatures are presented in charts and tables for the period January 1963 through December 1964. The charts show the monthly mean distribution of sea surface temperatures, and the tables give the mean monthly sea surface temperatures and anomalies for the center of all 5° latitude–longitude squares. The data acquisition and processing procedures are reviewed, and the data are briefly discussed. N.E.N.

N67-40052* Illinois Univ., Urbana. Aeronomy Lab.
AN AUTOMATIC RECORDING SYSTEM FOR THE DETERMINATION OF IONOSPHERIC ABSORPTION
Robert L. Appel and S. A. Bowhill 1 Sep. 1965 82 p refs
Its Aeronomy Report No. 7
(Grant NsG-511)
(NASA-CR-89782) CSCL 04A

The design and operation of an automatic recording system for the analysis of ionospheric absorption measurements is discussed. The system is intended to replace the visual measurement equipment presently being used by the Aeronomy Laboratory at the University of Illinois. The automatic recording system gives absorption measurements which are proportional to the mean amplitude of the reflected signal. In addition, the apparent reflection height of the transmitted wave is automatically determined. Two methods of recording the obtained data are described, as well as various applications of the proposed system. Author

N67-40063# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
ON THE THEORY OF TEMPORAL PERTURBATIONS OF THE GRAVITATIONAL AND MAGNETIC FIELDS IN CONNECTION WITH RECENT TECTONOPHYSICAL PROCESSES IN THE EARTH [K TEORII VREMENNYKH VOZMUSHCHENIY GRAVITATSIONNOGO I MAGNITNOGO POLEY V SVYAZI S SOVREMENNYMI TEKTONO-FIZICHESKIMI PROTSESSAMI V ZEMLE]
E. E. Fotiadi, G. I. Karatayev, and B. I. Shcheglov Aug. 1967 5 p Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 161, no. 3, 1966 p 590–592
(ACIC-TC-1248; TT-67-62626; AD-656998)

The translation of papers gives some results of investigations pertaining to the connection between temporal gravitational and magnetic potentials and the form, density and magnetization of the perturbing bodies that change in terms of time. Observations, usually over a 2-3 year period, are conducted at the same point. At some stations continuous daily observations are made for the changes in terms of time of the gravitational and magnetic fields and inclinations of the earths surface. At present, these observations are made in a number of regions of the USSR, including Siberia, where networks of stationary geophysical polygons have been developed. Magnetometers, gravimeters and tiltmeters are useful in this continuous observation. Author (TAB)

N67-40070# RAND Corp., Santa Monica, Calif.
ENERGETICS OF THE MIDDLE ATMOSPHERE
C. B. Leovy Sep. 1967 31 p refs Presented at the Surv. Symp. on Meas. in the Upper Atmosphere (ICMUA, IAMAP), 14th Gen. Assembly of IUGG, Lucerne, Switzerland, 28 Sep. 1967
(P-3679; AD-658422)

The middle atmosphere is considered to be the region from 25 to 105 km including the middle and upper stratosphere, mesosphere, and mesosphere-thermosphere transition region up to the turbopause. In the lower portion, up to 80 km, energy inputs and losses are predominantly due to absorption and emission of radiation by ozone, carbon dioxide, and water vapor, with solar absorption by ozone and emission by carbon dioxide playing the major role. Recent computations of heating and cooling rates due to these gases have not led to essential changes, but uncertainties remain. The principle ones are due to uncertainty in the concentrations of water vapor and ozone. TAB

N67-40142# Pennsylvania State Univ., University Park. Dept. of Electrical Engineering.
D-REGION PROCESSES IN NON-POLAR LATITUDES Scientific Report
A. P. Mitra 15 Jun. 1967 94 p refs
(Contract AF 19(628)-4014; Grant NSF GP-5611)
(SR-299; AFCRL-67-0418; AD-658450)

The report presents the results of a reexamination of three major areas of D region aeronomy, namely: the height distribution of nitric oxide, the distribution of the effective recombination coefficient and the nature and distribution of negative ions. For nitric oxide, a previous estimate by the author from the solar cycle variation in the D region electron density is supplemented by some new estimates from: observed diurnal variation of the electron density and from recent measurements of ion composition. These, and a few other ionospheric estimates currently available, as also considerations of the photochemistry of nitric oxide, indicate that a distribution consistent with most of these estimates is of the form n(NO) = 0.4 exp(-3700/T)n(O2) + 5 x 10 to the minus 7th power n(O). Values of the effective day time loss rate Psi have been obtained from simultaneous use of information on the ionizing radiation and several electron density profiles derived with rocket and ground-based experiments. Examination of these, as also the host of determinations on the effective recombination coefficient alpha that have in the past been made from the variations in electron density or absorption with the time of the day or during eclipses and solar flares, indicate that: (i) alpha has a value around 2 x 10 to the minus 7th power cu cm near 100 Km, (ii) the dissociative recombination coefficient for NO(+) is about the same as that for O(+2) (both being around 2 x 10 to the minus 7th power cu cm), and (iii) negative ions are not important above 70 Km during day and above 85 Km during night. The observational results appear to agree with an empirical relationship of the form. Author (TAB)

N67-40149# Pennsylvania State Univ., University Park. Dept. of Electrical Engineering.
ACOUSTIC WAVES IN THE IONOSPHERE Scientific Report
L. H. Wight 20 Aug. 1967 31 p refs
(Contract AF 49(638)-1708)
(SR-304; AFOSR-67-1904; AD-658449)

The independent solutions which correspond to an upgoing and downgoing acoustic wave in a viscous, non-heat conducting isothermal atmosphere are derived. The behavior of the perturbation density associated with the upgoing wave for large 1/Re is examined and found to be non-oscillatory. Houtl has shown that in the 100-130 kilometer region there are observed oscillations associated with the perturbation density of random acoustic waves. From the non-oscillatory behavior it is deduced that neither molecular nor eddy viscousity can be the damping mechanism. Further it is shown that including thermal conductivity cannot produce

the observed oscillations. The thermal gradient in the atmosphere is proposed to be a possible source of wave attenuation. The propagation of the upgoing wave through a small temperature jump is examined, and the effect of the discontinuity on the wave amplitude is found to be significant. Author (TAB)

N67-40164# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
ON THE INTRODUCTION OF THE TERRAIN CORRECTION IN GRAVIMETER OBSERVATIONS [O VVEDENII POPRAVKI ZA REL'YEF MESTNOSTI V GRAVIMETROVYYE NABLUDENIYA]
V. B. Naugol'nikov Jul. 1967 6 p Transl. into ENGLISH from Razved. Geofiz. (Moscow), Issue 8, 1965 p 99–103
(ACIC-TC-1219; TT-67-62629; AD-656990)

In geophysical literature, many works are dedicated to the calculation of the influence of the terrain relief upon the data of gravimetric measurements. At present, generally accepted methods of calculation consist of the computation and introduction of the so called correction for the terrain relief. This is an addition to the correction for the intermediate layer. Such problems as the connection between the topographic corrections and the reduction, the selection of an appropriate density value and methods for the introduction of the correction to gravimetric observations, require further studies. The connection of the topographic correction with the correction for the intermediate layer, as well as the selection of the density value for the computation of the correction for the relief, depending on the density value of the intermediate layer, are examined in this article. Author (TAB)

N67-40183 Illinois State Water Survey, Urbana.
THE EFFECT OF ARTIFICIALLY PRODUCED SPACE CHARGE ON THE ELECTRIFICATION OF CLOUDS Final Report
W. E. Bradley and R. G. Semonin 1 Sep. 1967 30 p refs
(Grant NSF G-3479)

The influence of an artificially produced space charge on the lower atmosphere and on the formation of precipitation was investigated. Examples are given of the perturbations in the atmospheric potential gradient and space charge resulting from the corona discharge of 45 kilometers (km) of high voltage line. It was shown that approximately 17 percent of the cumulus clouds that passed over the 130 km^2 charge source became electrified. During the 1962 season of operation there was a higher frequency of first echoes but less precipitation in the plume of charge area downwind of the wire than in the area surrounding the wire. The statistical significance of the results of the precipitation study is low, but the data indicate that there was not a marked increase in the precipitation immediately downwind of the artificial charge source. Author

N67-40187*# Illinois Univ., Urbana. Aeronomy Lab.
POSITIVE ION COLLECTION BY A SPHERICAL PROBE IN A COLLISION-DOMINATED PLASMA
R. J. Cicerone and S. A. Bowhill 1 Jun. 1967 79 p refs
(Grant NsG-511)
(NASA-CR-89747; Rept.-21) CFSTI: $3.00 CSCL 04A

The theory of operation of electrostatic probes in a slightly ionized, collision-dominated gas, such as the D-region of the ionosphere, is poorly understood. This report studies the collection of positive ions by a highly negative spherical probe in such a plasma for ratios of probe radius to Debye length of the order of unity. The theory is reviewed and the governing equations are developed. Due to the nonlinearity of the equations, a numerical method was necessary to solve the equations exactly. This method is explained in detail. The results are compared to those of Su and Lam (1963) and to the results of a zero space-charge theory. It is concluded that space charge may not be neglected. Author

N67-40218# Denver Univ., Colo. Dept. of Physics.
INFRARED RADIANCE OF SELECTED TERRAIN FEATURES AS VIEWED FROM HIGH ALTITUDE Scientific Report
David G. Murcray, Frank H. Murcray, and Walter J. Williams Bedford, Mass., AFCRL, Jul. 1967 52 p
(Contract AF 19(628)-4797)
(AFCRL-67-0448; SR-1; AD-658866)

A balloon flight was made July 8, 1966, with a downward looking spectral radiometer which measured the absolute spectral radiance of earth in the region from 8.5 to 16.0 microns as viewed from the balloon altitude. During the course of the flight the balloon traversed a number of different types of terrain. The observed spectral radiances show significant differences. Some of the differences appear to be due to changes in surface temperatures. There are a number of cases when the differences are definitely spectral in character and cannot be explained on the basis of temperature changes alone. It has not been possible however to associate the differences with any apparent geological parameter. Author (TAB)

N67-40225# New York Univ., N. Y. Geophysical Sciences Lab.
OPTICAL SOUNDING III Final Report, 1 Apr. 1966–30 Mar. 1967
Richard M. Schotland, James Bradley, and Alan Nathan Ft. Monmouth, N. J., Army Electronics Labs., Jun. 1967 29 p refs
(Contract DA-28-034-AMC-02207(E))
(ECOM-02207-F; Rept.-67-2; AD-657601)

Studies have been conducted utilizing simulated data of a ruby laser radar to study atmospheric water vapor profiles. Transfer equations have been evaluated incorporating 20 water vapor lines near 6943A. It is shown that the 6943.815A line stands essentially isolated in the telluric spectrum. An analysis is presented of the uncertainties in the deduced water profile obtained for simulated data based upon the 6943.815A line. It is shown that for the present laser radar, the uncertainty in the deduced water vapor density originated primarily in the uncertainty associated with the water vapor absorption coefficient. The Doppler-broadening of radiation scattered from aerosol particles or by Rayleigh scattering processes does not obey the spectral density shape predicted from the Maxwell-Boltzmann distribution of velocities for the particles or air molecules. As Dicke has pointed out, spectral narrowing can occur due to collisions. This phenomenon is discussed in relation to the Doppler spectrum of scattered radiation. The conclusions have been confirmed in experiments reported in the literature. Author (TAB)

N67-40240# Chicago Univ., Ill.
VARIATION IN THE ELASTIC CONSTANTS OF CALCITE WITH PRESSURE
Dattatreya Purushottam Dandekar (Ph.D. Thesis) Jun. 1967 51 p refs
(Contract ARPA SD-89; Grants NSF GP-3351; NSF GP-134)
(AD-659036)

The values of six elastic constants of single crystal calcite are determined to 6 kb at 25 C by the pulse-echo method. The ambient values of these constants agree fairly well with those obtained by Peselnick and Robie. The values of C-33, and C-66 do not change with pressure to 6 kb. These values are, respectively, 8.53 plus or minus 0.05 and 4.33 plus or minus 0.07 x 10 to the 11th power dynes/sq cm. The C-11 increases linearly from 14.63 x 10 to the 11th power dynes/sq cm at one atm. to 14.70 x 10 to the 11th power dynes/sq cm at 6 kb. The increases in the magnitude of C-13 and C-14 are non-linear. The variation of C-44 shows a maximum between 3 -4 kb. The possible reasons for such a maximum are qualitatively discussed. These results do not show any evidence of drastic change in the behaviour of calcite to 6 kb. Author (TAB)

N67-40272# Applied Research Lab., Waltham, Mass.
A MODEL FOR PROPAGATION OF ELF AND VLF WAVES BELOW NATURALLY PERTURBED IONOSPHERES
J. Galejs and M. Mentzoni Sep. 1967 35 p refs
(Contract Nonr-3185(00))
(RR-536; AD-658881)

A terrestrial propagation model is studied where the earth to ionosphere waveguide system is cylindrically stratified, the dip angle of the static magnetic field is assumed to be arbitrary and the waves propagate in East to West or West to East directions at a constant magnetic latitude. The profiles of ionospheric electronic density chosen for the numerical computations are representative of sudden ionospheric disturbances (SID), solar flares, auroral absorption or polar cap absorption (PCA) events. The resulting phase velocity and attenuation rates of ELF and VLF signals are compared with those computed under representative quiet daytime conditions. PCA events (which give the most dramatic effects) cause a lowering of the effective ionosphere; the resulting propagation is nearly isotropic and the phase velocities are decreased at ELF and increased at VLF. The attenuation rates are increased at ELF and also in the lower part of the VLF band. The propagation parameters are affected to a lesser degree by the other events: ionospheric density perturbations at heights below 60 km have more readily discernable effects at ELF, while the changes of the ionospheric density gradient at larger heights are observable at VLF. However, these differences are not uniquely distinguishable from propagation characteristics obtainable under quiet daytime conditions.
Author (TAB)

N67-40274# American Meteolorological Society, Boston, Mass.
EXCERPT FROM THE REPORT OF THE SOVIET GEOPHYSICAL COMMITTEE, ACADEMY OF SCIENCES OF THE USSR, TO THE 14TH GENERAL ASSEMBLY OF THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS
Bedford, Mass., AFCRL, Aug. 1967 40 p refs Transl. into ENGLISH of the book "Izvlechenie iz Otcheta Mezhduvedomstvennogo Geofizicheskogo Komiteta pri Prezidiume Akademii Nauk SSSR XIV General'noi Assamblee Mezhdunarodnogo Soiuza Geodezii i Geofiziki" Moscow, 1967 47 p
(Contract AF 19(628)-3880)
(T-R-669; TT-67-62939; AD-658824)

The report is an excerpt from the report of the Soviet Geophysical Committee, Academy of Sciences of the USSR, to the 14th General Assembly of the International Union of Geodesy and Geophysics. The report on the determination of the figure, dimensions, and gravitational field of the earth relates scientific research and its approach to the problem.
Author (TAB)

N67-40280# Eidgenossische Technische Hochschule, Zurich (Switzerland).
THEORETICAL STUDY OF MAGNETIC ATTRACTION DUE TO ROCK BODIES AND EXPERIMENTAL INVESTIGATION OF THE STABILITY OF ROCK MAGNETISM
Prem Vallabh Sharma (Ph.D. Thesis) 1966 36 p refs *Its* Dissertation No. 3840
CFSTI: HC $3.00/MF $0.65

With the aid of formulae derived for the field caused by a finite rectangular prism, a machine method is developed for rapid computation of magnetic anomalies due to a body of any shape. Conversely, the method could be utilized for determination of the magnetization vector from the observed anomalies. An example is given to demonstrate the applicability, accuracy and speed of the method. The method is shown to be suitable also for the evaluation of magnetic terrain effects. In addition, a new method is presented which enables high speed calculation of demagnetization effect caused by a body of arbitrary shape where the magnetization in general may be inhomogeneous. Applicability and accuracy of the method are discussed. The method is applied to study the effect of susceptibility on inhomogeneity of the induced magnetization in a cube specimen. For a body of any shape with low susceptibility, a new concept of average demagnetization factor is introduced. Average demagnetization factors so calculated for a cylindrical specimen are tabulated.
Author

N67-40285 Joint Publications Research Service, Washington, D. C.
SOVIET-BLOC RESEARCH IN GEOPHYSICS, ASTRONOMY, AND SPACE, NO. 166
18 Oct. 1967 154 p refs
(JPRS-42999; TT-61-11147-166) CFSTI: HC $3.00

News reports and abstracts of scientific articles are presented on data pertaining to astronomy, meteorology, oceanography, terrestrial geophysics, space research in the upper atmosphere, the movement of glaciers, and deep drilling of boreholes.
M.G.J.

N67-40286 Joint Publications Research Service, Washington, D. C.
CONSTRUCTION OF SPACE (COSMIC) POLYGONOMETRY
O. S. Razumov 19 Oct. 1967 13 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Geod. i Aerofotos. (Moscow), no. 2, 1966 p 49–57
(JPRS-43027; TT-67-33652) CFSTI: $3.00

Several examples are given of the use of space polygonometry as a base for intercontinental geodetic connection. This geodetic system, consisting of a three-dimensional polyhedron formed by chords of the terrestrial ellipsoid, is constructed in the field by making pulsed-sound range finder measurements for determining the lengths of its sides and synchronized observations of artificial earth satellites or finding the directions of these sides in space. Elements of trilateration and cosmic triangulation are included.
Author

N67-40298# Philco-Ford Corp., Billings, Mont. Education and Technical Services Div.
MONTANA LASA LIGHTNING ACTIVITY FOR 1966
B. L. Ramsey May 1967 45 p
(AD-658177)

The report covers lightning activity within the Montana LASA during 1966 with excerpts from 1965 reports when applicable. Included are observations of lightning activity, damage to LASA equipment, a description of present lightning protection circuitry, and discussions of the lightning counter experiment and subarray B4 Carbon Block check conducted during the year. Lightning season as used in this report refers to the period of 1 Jun through 30 September. A summary comparison of 1965 vs. 1966 figures in several categories is shown in Table 1. The method used to obtain the 1966 figures is explained in each category.
Author (TAB)

N67-40310 Defence Research Board, Ottawa (Ontario). Telecommunications Establishment.
ALOUETTE 1 IONOSPHERIC DATA INTERPOLATED N(h). VOLUME 4
1 Aug. 1967 472 p

Electron number densities are presented for heights from 1000 km to 250 km in increments of 50 km. The tabulated data are applicable for those profiles published in the series of Alouette I Ionospheric Data—N(h) Profiles. The number densities at these heights were determined by linear interpolations in plasma frequency. The tabulations are preceded by an index which indicates the data available in other volumes of this series.
K.W.

N67-40363# Air Force Cambridge Research Labs., Bedford, Mass.
ON THE ACCURACY OF CERTAIN APPROXIMATIONS FOR THE CHAPMAN FUNCTION
William Swider, Jr. and Margaret E. Gardner (Boston Coll.) Aug. 1967 16 p refs *Its* Environ. Res. Papers, No. 272
(AFCRL-67-0468; AD-658826)

Practical approximations for the Chapman function over the entire range of possible solar zenith angles are considered. The approximations are numerically evaluated for a selected number of parametric values. Comparison with the Chapman function on a percent difference basis is provided. Some practical points regarding geometry are discussed for angles exceeding pi/2.
Author (TAB)

N67-40377# Lincoln Lab., Mass. Inst. of Tech., Lexington.
MIDLATITUDE F REGION DENSITIES AND TEMPERATURES AT SUNSPOT MINIMUM
John V. Evans. 21 Aug. 1967 54 p refs
(Contract AF 19(628)-5167)
(ESD-TR-67-479; TN-1967-41; AD-658837)

Results obtained for F region densities and temperatures using the Millstone Hill Ionospheric Radar for the year 1964 are presented. The measurements were made during 30-hour periods which followed at intervals of about two weeks throughout the year. The data obtained in each month have been averaged to yield a mean electron density profile and mean ion and electron temperature curves for each hour in the day. These curves were in turn used to construct plots showing contours of constant temperature and density as functions of altitude and time for each month. In addition, the annual variation of the midday and midnight densities and temperatures was obtained. The seasonal anomaly in the F region peak electron density is evident though less pronounced than at years of high sunspot number. The F region layer thickness undergoes a smooth transition from winter to summer, being greatest in summer. It is shown that the daytime temperatures exhibit no marked seasonal dependence, and hence temperature effects (e.g., on reaction rates) cannot be invoked as the cause. The most striking nighttime phenomenon is the high electron temperature encountered in winter (Te/Ti approximately equals 2.0) compared with summer. Evidence is presented for the existence of a flux of fast photoelectrons arriving from the conjugate ionosphere. The nighttime heating of the F region is thought to be caused by heat conducted down from the protonosphere together, in winter months, with the flux of fast photoelectrons from the conjugate hemisphere. During the daytime, heat appears to be conducted down through the 500-km altitude level at a rate of approximately equals 5 x 10 to the 9th power eV/sq cm/sec.
Author (TAB)

N67-40469*# Illinois Univ., Urbana. Aeronomy Lab.
COLLISION FREQUENCIES AND ELECTRON TEMPERATURES IN THE LOWER IONOSPHERE
J. E. Salah and S. A. Bowhill. 15 Aug. 1966 111 p refs *Its* Aeronomy Rept.-14
(Grant NsG-511)
(NASA-CR-89784) CFSTI: $3.00 CSCL 04A

The question of thermal equilibrium in the lower ionosphere has recently led to several conflicting theories. A method for the extraction of electron and neutral temperatures from experimental data is described, and the results of application to several rocket flights are presented. The electron temperature is derived from the electron collision frequency which is determined by propagation techniques. This involves the measurement of the differential absorption and Faraday rotation of two waves propagating in the ionosphere. The neutral temperature is obtained from the scale height of molecular oxygen, determined from the measurement of the absorption of solar ultraviolet radiation. The various experimental and analytical techniques are described in detail.
Author

N67-40504# European Space Research Organization, Paris (France).
AURORAL AND ASSOCIATED MAGNETOSPHERIC PHENOMENA AT VERY HIGH LATITUDES
1965 439 p refs Proc. of the ESRO Colloq. held in Stockholm, 16-18 Nov. 1965
(ESRO-SP-8; CONF-651156)

Papers are presented on various aspects of magnetospheric theories, magnetic measurements, relations between the outer magnetosphere and ionospheric phenomena, particle measurements, and vlf and elf waves in the magnetosphere. The following topics are included: importance of electric fields in the magnetosphere, magnetic storm effects associated with the tail of the magnetosphere, the open magnetospheric model, neutral points on the boundary of the closed magnetosphere, measurements of the magnetic field in the outer magnetosphere and boundary conditions, coupling between the outer magnetosphere and the high-latitude ionosphere, dynamical model of auroral morphology, magnetic field measurements in the high-latitude magnetosphere, measurements of electric fields in space, measurements of electric fields in the ionosphere and magnetosphere, theory of electric field measurements conducted in the magnetosphere with electric probes, satellite measurements of low-energy particles precipitated at high latitudes, energetic particle observations from IMP satellites, observations of particles in the tail of the magnetosphere by Vela satellites, suggestions for magnetospheric experiments, particle measurements on an ESRO satellite (Neutral I) in a highly eccentric polar orbit, and possible particle measurements in the high-latitude magnetosphere.
NSA

N67-40543 National Physical Lab., New Delhi (India).
ELECTRON CONTENT MEASUREMENTS OVER DELHI FROM FARADAY FADING OF SATELLITE EXPLORER-22(S-66) TRANSMISSIONS Scientific Report, Jan.–Dec. 1966
Tuhi Ram Tyagi 15 May 1967 16 p *Its* Satellite Data Ser. No. 2
(RPU-S-33; SR-33)

This report contains the electron content values recorded by Explorer-22 transmissions on 20, 40, and 41 MHz during the period January 1966, through December, 1966. Also included are the F-2 values deduced from corresponding C-4 ionograms, solar flux, and magnetic index values for references.
G.G.

N67-40594# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
NEOTECTONICS AS INDICATOR OF ANOMALOUS THICKNESSES OF THE EARTH'S CRUST [NEOTEKTONIKA KAK POKAZATEL ANOMAL'NYKH MOSHCHNESTAY ZEMNOY KORY]
V. G. Rikhter and I. S. Vol'vovskiy. Aug. 1967 41 p Transl. into ENGLISH from Sov. Geol. (Moscow), no. 12 1966 p 118–123
(ACIC-TC-1246; AD-656999)

Many geologists have devoted their investigations of recent movements of the earths crust, and to the morphological expressions of these movements. The knowledge of the causes of the tectonic movements of the earths crust is important because it will be helpful in decoding the regularities in the vertical motions during remote geological epochs and in the solution of the problem of energy in tectonic processes. It is important to determine whether the latter are a reflection of abyssal processes occurring in the earths crust and the upper mantle, or if they are basically caused by external forces in relation to the earth. This translation is a study of various Soviet scientists data, indicating the relation between thickness of the earths crust and relief elevations. The graphic compiled by R. M. Demenitskaya is especially considered. Graphics compiled by other scientists differ from the considered one only in the regions of great oceanic depths and great elevations of the relief on the land. In order to obtain the data for the comparison, elevations of the earths surface relief were not used. The maximum of the tectonic movements were used because they reflect more accurately the processes in the abyssal layers of the earths crust and in its upper mantle.
Author (TAB)

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

N67-39489# Colorado State Univ., Fort Collins. Fluid Dynamics and Diffusion Lab.

ULTRA LOW-SPEED ANEMOMETRY

Robin J. Kung and G. J. Binder Jun. 1967 130 p refs
(Grant DA-AMC-28-043-65-G20)
(CER66-67RJK49; AD-658172)

An investigation of low-speed (0-2 ft/sec) anemometers is presented. First the design, the characteristics and the calibration of a very low-speed micro wind tunnel are described. Then the principle, operation and performance of three different anemometers at these low speeds are discussed. These instruments are: (1) hot-spot anemometer, based on the measurement of the traveling time of a hot cloud, (2) drag anemometer which consists of a small plate mounted to the moving coil mechanism of a micro-ammeter, (3) constant temperature hot-wire anemometer. The comparison of the merits and disadvantages of these instruments shows that in most instances the hot-wire anemometer is superior to the two other anemometers. Author (TAB)

N67-39532# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.

A WIDE RANGE TIME TO PULSE HEIGHT CONVERTER USING A TRANSISTOR IN THE AVALANCHE SWITCHING MODE

Paul A. Hofhine May 1967 26 p refs
(Contract AT(10-1)-205)
(IDO-17225) CFSTI: HC $3.00/MF $0.65

A solid-state time-to-pulse-height converter is described whose output pulse height is proportional to the time between the input pulse and a reference pulse. The instrument utilizes the sweep voltage from an oscilloscope to control the output pulse amplitude. This provides a wide range of values for the maximum or full-scale time input. A deviation from linearity of less than ±1/4 percent of the maximum output has been achieved. The unit incorporates a diode sampling gate, driven by an avalanche transistor, to achieve a sampling time of less than a nanosecond. Author (NSA)

N67-39561# Los Alamos Scientific Lab., N. Mex.

EVALUATION OF LENSES FOR USE IN ALL-SKY PHOTOMETERS

Guy E. Barasch 5 Sep. 1967 20 p refs
(Contract W-7405-ENG-36; ARPA Order 631)
(LA-3727; AD-657955) CFSTI: HC $3.00/MF $0.65

For maximum performance, an all-sky photometer should have a large light-collection area and a narrow spectral passband; however, for a given size of photometer, these parameters cannot be optimized simultaneously. Three compromise lens designs are evaluated here: LASL-2, a 0.43-in.-focal-length, F/2.8, 160 degrees-field-of-view lens for use with a 2-in.-diam. photomultiplier tube; and, for use with 5-in.-diam. photomultiplier tubes, LASL-5 a 2.1-in.-focal-length, F/4.0, 120 degrees-field-of-view lens; and EG+G-5, a lens with a nominal 120 degrees field of view, which can be used with or without an ND2 filter covering the central part of the first element. The effective on-axis entrance-pupil areas and the relative response curves as a function of wavelength and incidence angle were measured, and the results are reported. Therefore, LASL-5 photometers are recommended for systems like the Los Alamos air fluorescence detection system, which for optimum performance require widefield photometers with narrow, well defined, spectral passbands. Author (TAB)

N67-39562# Army Weapons Command, Rock Island, Ill. Research and Engineering Div.

USE OF THE ELLIPSOMETER IN THE MEASUREMENT OF THIN FILMS Technical Report, Jul. 1965–Oct. 1966

Bernard J. Bornong Jul. 1967 37 p refs
(RIA-67-1859; AD-658063)

Work was performed to outline procedures for use of the ellipsometer in thin film measurement for basic studies on corrosion and corrosion inhibition. The Poincare sphere was used as a geometrical model to analyze ellipsometer readings in terms of polarization forms of light. Changes in polarization form were used to obtain thickness and refractive index of thin films of adsorbed inhibitors or corrosion products. A five-layer barium stearate film and adsorbed monolayers of stearic acid on chrome were measured. Conclusions are that procedures outlined in the report give results consistent with published results. Ellipsometry measures films with thickness of the order of molecular dimensions. Film growth in adsorption and corrosion processes can be observed beginning in their earliest stages. TAB

N67-39598# Fabric Research Labs., Inc., Dedham, Mass.

BIAXIAL TENSILE TESTER FOR FABRICS

Robert E. Sebring and Denny W. Freeston, Jr. Natick, Mass., Army Natick Labs., May 1967 104 p refs
(Contract DA-19-129-AMC-1042(N))
(TR-67-71-GP; AD-658684)

The overall goal of the program is the development of an instrument for determining the stress-strain response of coated fabrics used in the construction of air-supported tents. During Phase I of the program a survey of the scientific literature on biaxial tensile testers was carried out. The purpose of the survey was to examine the design features and operating techniques of previously constructed testers and to note design innovations and shortcomings. A theoretical analysis of the load-extension behavior of idealized plain-weave fabrics subjected to biaxial stresses is presented. Fabric strains resulting from both crimp interchange and yarn extension are considered. The analytical expressions derived have been solved with the aid of a digital computer for both linearly elastic and elasto-plastic materials. Time effects, although not explicitly included, are discussed. Generalized plots of the results are given for the two extremes of initial fabric structure: (1) equal crimp distribution in both sets of yarns; (2) one set of yarns straight (noncrimped). The predicted and measured response of two model fabrics are compared. Two typical coated fabrics representing approximately the extremes in fabric weight and strength currently of interest for air-supported tent applications were evaluated. The design of an improved biaxial tensile tester is outlined. The proposed design concept utilizes the results of the literature survey, model fabric study and coated fabric evaluation. Author (TAB)

N67-39649*# Department of Agriculture, Washington, D. C. Natural Resource Economics Div.

AGRICULTURAL APPLICATION OF REMOTE SENSING. THE POTENTIAL FROM SPACE PLATFORMS

H. Thomas Frey Sep. 1967 35 p refs Inform. Bull. No. 328
(NASA Order R-09-038-001)
(NASA-CR-89845) CFSTI: $3.00 CSCL 08G

Current research and literature were reviewed to identify agricultural applications of remote sensing by low altitude space platforms. Existing photographic sensors and photograph interpretation techniques were found to be adequate to perform a variety of agricultural survey tasks from space platforms. Reconnaissance surveys of major land uses, soils, water bodies, range conditions, and cropping practices are technically feasible. Consistent and accurate identification of crop species, analysis of

crop vigor, and estimation of crop production are not clearly feasible. However, such interpretations as these are probable in special situations using photographic methods. The development of nonphotographic sensing and interpretation capabilities may result in substantial information gains, particularly when used in conjunction with photographic imagery. Detailed soil surveys and livestock censuses appear unattainable from space altitudes because of inadequate resolution and interpretation techniques. R.N.A.

N67-39693# Sandia Corp., Albuquerque, N. Mex. Advanced Systems Development Div.
ELECTRONIC GENERATION OF QUADRATURES FOR SINUSOIDAL TRANSDUCERS
J. W. Campbell Aug. 1967 62 p refs
(SC-RR-67-575) CFSTI: HC $3.00/MF $0.65

The use of most transducers whose output is a sinusoidal function of the input has been limited due to the difficulty of resolving the ambiguity in their outputs. A technique is presented for electronically generating the quadrature information which resolves this output ambiguity. A mathematical model for this technique is developed, including practical considerations for implementation. Experimental confirmation of the technique is reported; this confirmation is supplied by resolving the ambiguity of the Laser Feedback Interferometer which heretofore was not possible. Author (NSA)

N67-39706# California Univ., Los Angeles. Meteorology Dept.
GAIN COMPENSATED PHOTOPOLARIMETER FOR AIRBORNE MEASUREMENTS OF SKYLIGHT POLARIZATION
Gerald F. Chesebrough, Daniel F. Dibble, and C. R. Nagaraja Rao Jun. 1967 34 p refs
(Contract F19628-67-C-0196)
(AFCRL-67-0396; SR-1; AD-658194)

The design and performance of a simple battery operated, electronic-servo governed photoelectric polarimeter are presented and discussed. A rotating Glan prism is used as the analyzer. Measurements of the degree of linear polarization and relative intensity variations can be made in four narrow spectral intervals (band width approximately equals 150 A) centered on wavelengths 3620, 4010, 5010 and 5990A. The variations in the intensity of the incoming light beam are compensated by varying the gain of the photomultiplier tube with the use of a programmable high voltage supply governed by an electronic servo the error signal for which is derived from the instantaneous value of the photosignal after rectification. Variations in intensity of three to four orders of magnitude can easily be accommodated with the present system. Because of its light weight, reasonably low power consumption and characteristic requirement of a single operational command, the polarimeter is eminently suited for use when both the operation and data acquisition are to be interfaced with a telemetry system as in a high altitude balloon flight. Author (TAB)

N67-39722# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
A SINGLE CHANNEL SCINTILLOMETER FOR HEALTH PHYSICS
A. R. Jones Sep. 1967 21 p ref
(AECL-2767) Available from Atomic Energy of Canada, Ltd., Chalk River: $0.50

The single channel scintillometer detects gamma rays of a particular energy, which can be selected, efficiently. It detects other gamma rays inefficiently. It is small, rugged and operates from line power or internal rechargeable batteries. The mechanical construction, circuit operating principles, and some circuit details are described. Efficiencies for the detection of various isotopes and other performance data are presented. The application to problems in health physics is discussed. An appendix explains the operation and maintenance. Author

N67-39742* Teledyne Systems Corp., Hawthorne, Calif.
ULTRA MINIATURE TELEVISION CAMERA Final Report, Jul. 23, 1965–Jun. 30, 1966
R. J. Deterville and N. Drago Jul. 1966 30 p
(Contract NASw-762)
(NASA-CR-89625) CSCL 14E

An ultraminiature television camera compatible with the functional requirements of the technical specifications was produced. Hardware configurations of the prototype are described and appropriate schematics included. Author

N67-39759* Minnesota Univ., Minneapolis. Cosmic Ray Group.
DESIGN FOR ORIENTATION OF BALLOON-BORNE EQUIPMENT
Gerald A. Anderson Jun. 1967 18 p
(Grant NGR-24-005-050-122; Contract Nonr-710(60))
(NASA-CR-89685; CR-96) CSCL 03A

The design of a system to orient a balloon-borne instrument package about a vertical axis is presented. The pointing accuracy obtained is ±1.5°. An independent photographic recording system measures the azimuth angle with respect to the star Polaris to ±0.1°. The instrument package is rotated against a light weight reaction wheel which is designed for maximum moment of inertia. A pulse width modulation system is used to drive the orientation motor. A fluxgate magnetometer, used for the sensor element, causes the instrument package to be oriented with respect to the horizontal component of the earth's field. The instrument, a gamma-ray telescope, is oriented in the north–south plane and is tilted at an angle with the vertical which will correspond with the elevation of the suspected gamma ray source when the source crosses the local meridian. Author

N67-39805 Canadian Meteorological Society, Toronto (Ontario).
A SATELLITE PHOTO INTERPRETATION KEY
Roy Lee and Charles I. Taggart *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 33–37 (See N67-39802 24-20)

The problem of using satellite pictures at a regional office interested only in a limited portion of the atmosphere is discussed. A solution involves three factors, (a) adjustment and familiarity to a new point of view, (b) acquiring knowledge and experience in recognizing cloud forms from satellite altitudes, and (c) adopting the systematic approach of the professional photo-interpreter to satellite pictures, namely, the principle of convergence of evidence. Two charts summarizing the appearance of clouds from satellite altitudes together with a systematic approach to satellite photo interpretation are presented. Author

N67-39810 Sacramento Peak Observatory, Sunspot, N. Mex.
A SOLAR FLARE VIDEOMETER
Paul E. Tallant *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 92–109 refs (See N67-39802 24-20)

An experimental electronic instrument designed to measure flare area, peak intensity and integrated intensity as functions of time is described from a functional standpoint. The instrument processes video signals obtained from a closed circuit television system used to view the Hα solar image. Some early observations with the instrument are described and compared with radio and X-ray data. Author

N67-39838# Army Electronic Labs., Fort Monmouth, N. J.
AUTOMATIC COUNTING OF ATMOSPHERIC AEROSOLS COLLECTED WITH THE GOETZ ULTRACENTRIFUGE
Hermann E. Gerber Jun. 1967 39 p refs
(ECOM-2852; AD-658667)

An automatic counter was developed with which submicron aerosol data, collected with the Goetz Aerosol Spectrometer ultracentrifuge was rapidly and accurately evaluated. The data, consisting of 35mm microphotographs of large numbers of aerosols, were reduced by utilizing a unique track-scanning geometry in

conjunction with a mechanical planar scanner. The photographic images of the aerosols and their locations on the data field were considered in detail, and appropriate corrections were derived to compensate for coincidence counting losses and the variable opacity of the images. Using the automatic counter, it was possible to count up to 500 aerosol images on a 2.0 sq cm area on each microphotograph. The counts were accomplished with a standard deviation of approximately 0.20 times the magnitude of the inherent statistical uncertainty of the data; also, each microphotograph was automatically scanned and counted in 140 seconds. Author (TAB)

N67-39842# Mound Lab., Miamisburg, Ohio.
WATER BATH CALORIMETER, NUMBER 94
J. H. Birden, W. A. Dudley, K. C. Jordan, J. D. Nutter, F. A. O'Hara et al. 12 Jul. 1967 23 p refs
(Contract AT(33-1)-GEN-53)
(MLM-1341) CFSTI: HC $3.00/MF $0.65

An isothermal water bath calorimeter capable of measuring large (volume) heat sources is described. An internal four-terminal calibration heater with associated power supplies and accurate measuring console make it an absolute system. Due to its basic engineering design, the percentage accuracy and precision errors should be approximately constant on all power ranges. A probable error of 0.104% for a single observation was obtained from nine observations of a standard 3.1893-watt heat source; a conservative overall value would be 0.25%. The grand mean value was 0.017% higher than the standard value. The useful measuring range is from 3 to 150 watts. Author (NSA)

N67-39856# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
A SOLID-STATE CIRCUIT FOR A REACTOR PERIOD SIMULATOR
J. S. Byrd Jul. 1967 8 p refs
(Contract AT(07-2)-1)
(DP-1119) CFSTI: HC $3.00/MF $0.65

A solid-state circuit was constructed that provides an exponentially rising or falling electric current from 10^{-12} to 10^{-4} amp. This circuit is used in a convenient and reliable period simulator that tests the electronic response of instruments monitoring the neutron flux level in a nuclear reactor. Author (NSA)

N67-39877# Universidad Nacional de Colombia, Bogota. Facultad de Ciencias.
NOMOGRAM FOR THE TURBIDITY OF PHOTOGRAPHS [NOMOGRAMA PARA LA BORROSIDAD DE LAS FOTOGRAFIAS]
Marijan Bomhard Badovinac *In its* Nomograph Seminar 1967 p 65–74 (See N67-39870 24-19)

The parameters and formulas used in the construction of a nomogram for determining the turbidity of photographs are presented. Transl. by R.N.A.

N67-39885# Pennsylvania Univ., Philadelphia. Dept. of Electrical Engineering.
A SOLID STATE POLARIMETER SUITABLE FOR ROCKET-BORNE IONOSPHERIC DIFFERENTIAL ABSORPTION MEASUREMENTS Scientific Report
Dan H. Marshall, II 31 May 1967 90 p refs
(Contract F19628-67-C-0301)
(SR-298(E); AFCRL-67-0373; AD-658451)

The design of a solid state polarimeter is presented and compared to that of a previous polarimeter on the basis of phase shift, propagation delay, and amplitude response. For background, polarimeter uses in determining differential absorption by rocket-borne methods and wave polarization with regard to characteristics of the ionosphere and measurements thereof are reviewed. An optimum noise figure comparison is made for both a vacuum tube and a transistor low level input amplifier stage. A comprehensive outline of adjustment procedures is also presented, including a graphical presentation of the most significant system parameters. Author (TAB)

N67-39906* Illinois Univ., Urbana. Ionosphere Radio Lab.
A SOLID-STATE PROGRAMMABLE DIGITAL CLOCK
S. Chalasani and B. J. Flaherty Aug. 1967 53 p refs
(Grant NsG-24)
(NASA-CR-89737; TR-30) CSCL 09C

Laboratories such as those engaged in recording data from satellites have long felt the need for a special purpose, programmable, accurate and reliable digital clock to automatically record their data at preset times. Such a solid-state digital clock has been designed and actually constructed to have four ON settings. When the preset ON time coincides with the indicated time, the clock outputs a 4.5 volt pulse of one minute duration to operate the recording equipment. A separate timing motor determines the duration of the data recording. The clock has been built with a 200 KHz oscillator (long term stability $\pm 1 \times 10^{-6}$ per day), integrated circuit decade dividers, decoders, NAND gates, transistorized AND gates, flip-flops, etc. It has been shown how the design can be extended to include four corresponding OFF settings to control the duration of the recording time. It has also been shown that, theoretically, the ON settings on the clock can be increased to a maximum of 60 or, alternately, a clock with 30 ON settings and 30 OFF settings. Author

N67-39917 Defense Standards Labs., Maribyrnong (Australia).
A RAPID METHOD OF ALIGNING THE MACH–ZEHNDER INTERFEROMETER
D. B. Prowse Aug. 1967 5 p refs
(TN-100)

Aligning procedures are outlined for the method involving a precision optical autocollimator along with a parallel sided reflecting piece. It is pointed out that white light fringes can be obtained in less than an hour, and the method ensures all mirrors are parallel. N.E.N.

N67-39987*# Chrysler Corp., New Orleans, La. Space Div.
TEST REPORT FOR PRESSURE TRANSDUCER GIANNINI CONTROLS CORPORATION PART NUMBER 461319 NASA DRAWING NUMBER 75M61731-6-2000
C. L. Foy 13 Jul. 1967 95 p
(Contract NASS-4016)
(NASA-CR-89775; TR-RE-CCSD-FO-1001-3) CFSTI: $3.00 CSCL 14B

This report presents the results of functional and environmental tests performed on three specimens of a pressure transducer. The maximum pressure which could be measured by specimens 1, 2, and 3 was 1965, 2005, and 2005 psig, respectively. The total output resistance of the specimens was out of tolerance during the low and high temperature tests and the measured calibration points were not all within the maximum static error band. Maximum degradation occurred at approximately 900 cps during each of the vibration sinusoidal sweep tests. The measured calibration points were not all within the maximum static error band after the vibration tests. The output voltage of specimens 2 and 3 began to fluctuate between 900 and 1100 psig after 500 cycles of the cycle test. There was no output (open circuit) at 985 psig after the cycle test. Author

N67-39994# American Optical Co., Pittsburgh, Pa. Space Defense Group.
BALLOON BORNE TELESCOPE FEASIBILITY STUDY AND DESIGN Final Report, 1 Jun. 1965–30 Sep. 1966

Allan Langord, Thomas Prevenslik, and Richard Walters Aug. 1967 81 p
(Contract AF 19(628)-5150)
(FR-12; AFCRL-67-0318; AD-659051)

The document is the final report of a balloon-borne selenodetic telescope study. Several basic telescope optical systems and their characteristics are discussed with an optimum configuration selected as the basis for the final design. Mechanical structures, thermal problems, focus control, and coarse and fine trading techniques are described. A section on expected system operation costs, based on historical data from previous balloon-borne experiments, is also included. Author (TAB)

N67-40007 Institute for Perception RVO–TNO, Soesterberg (Netherlands).
DISCRIMINATION AND IDENTIFICATION IN NOISY LINE-SCAN PICTURES
W. A. Wagenaar and A. van Meeteren [1967] 26 p refs
(IZF-1967-16; TDCK-49168)

Interpretation of line-scan pictures was examined as a function of image degradation. Pictures were produced with a flying-spot-scanner system. Degradation was achieved by varying the line frequency and by adding noise. Eight subjects were instructed to indicate which object was imaged on the picture presented. Scores are plotted as a function of line frequency for three signal to noise ratios and three different groups of military vehicles. Maximum scores are reached for line frequencies between 3 and 5 lines per m in reality. Incorrect answers were analyzed with respect to the structure of the confusions. The various kinds of confusions lead to a series of interpretation tasks with increasing complexity. Author

N67-40090* Bell Aerosystems Co., Cleveland, Ohio.
STERILIZABLE ACCELERATOR Quarterly Technical Report, May–Jul. 1967
A. K. Hoffmann and F. A. Petsock 22 May 1967 57 p
(Contract JPL-951492)
(NASA-CR-89595; Rept.-60007-029) CSCL 14B

Accelerometer M-225 was rebuilt with new springs whereby the Scotchweld EC-2258 was again applied in the spring-to-support joints. The flip–flop soak tests resulted in a bandwidth of 255 micro g before temperature sterilization and 453 micro g after temperature sterilization, which is the best result obtained so far in this program. During the experimentation with accelerometer M-225 prior to its rebuilding, the pendulum showed signs of sticking to the capacitance rings. During reassembly after cleaning of the instrument the springs were accidentally broken, which caused a severe schedule setback. An assembly procedure allowing surface protection to be applied to the capacitance rings was experimentally applied. Electroless goldplating appears promising. Progress was made in the building of transformers and electronic assemblies designed to meet the temperature sterilization environment. Author

N67-40104# Uppsala Univ. (Sweden). Inst. of Physics.
PROPERTIES OF AN ALTERNATING DIRECTION IMPLICIT METHOD IN THE CALCULATION OF A MAGNETIC FIELD FROM A MEASURED BOUNDARY
T. Groth, B. Olsen, and G. Pettersson [1967] 23 p refs
(UUIP-536)

An alternating direction implicit (ADI) method was applied to the problem of calculating the components of a magnetic field in a grid, when values of the components are given on the boundary. The calculations were applied to the axially symmetric case of a long-lens spectrometer. The procedure may be extended to a multidimensional case. The influence of two kinds of errors were investigated. The ADI method turns out to be useful as soon as an accurate determination of a magnetic field in a region is of interest, e.g., for cyclotron calculations and investigations of different types of magnetic lenses. Author (NSA)

N67-40105# Uppsala Univ. (Sweden). Inst. of Physics.
CONTROL SYSTEM FOR THE PLATE MOVEMENT OF A TELEVISION MICROSCOPE USED AS A PHOTOMETER
Tord Berglund, Robert Carlsson, Anders Fahlman, and Kai Siegbahn May 1967 12 p refs
(UUIP-544)

A control system for the plate movement of a new television microscope is reported. The plate is moved by two step motors and the movement is controlled electronically. This system makes the television microscope a very efficient photometer. The apparatus can also be used for other purposes, e.g., studies of dislocations. Author (NSA)

N67-40152*# Research Triangle Inst., Durham, N. C. Measurement and Controls Lab.
EXPERIMENTAL VERIFICATION OF GAMMA RAY ATMOSPHERIC DENSITY SENSOR MATHEMATICAL MODEL PREDICTIONS
R. P. Gardner and D. R. Whitaker Aug. 1967 71 p refs
(Contract NAS1-7046)
(NASA-CR-66476) CFSTI: HC $3.00/MF $0.65 CSCL 14B

The gamma-ray scattering technique shows promise for use in the continuous measurement of atmospheric density from space vehicles. Mathematical models have been derived to predict the performance, identify problem areas, and explain the data taken on two flight tests of prototype devices. Design parameters such as gamma-ray source energy, source-to-detector separator, detector discriminator settings, and shield effectiveness were studied in an attempt to understand and optimize this technique. Subsequently, experimental studies were made to verify and improve (determine constants for) these mathematical models. The experimental results agreed quite well with the model predictions and prove the effectiveness of this method for optimizing the design of the gamma-ray atmospheric density sensor. Author

N67-40158* National Aeronautics and Space Administration, Washington, D. C.
MONOMETRIC GAGE WITH OUTSIDE COLLECTOR FOR VERY LOW PRESSURES [JAUGE MANOMETRIQUE A COLLECTEUR EXTERIEUR POUR PRESSIONS TRES BASSES]
J. Groszkowski Oct. 1967 11 p refs Transl. into ENGLISH from Bull. Acad. Polon. Sci. (Warsaw), v. XIV, no. 10, 1966 p 169–177
(NASA-TT-F-11349) CSCL 14B

Special vacuum gauges with mobile collectors and which operate without a magnetic field, are described. The instrument can be applied to a vacuum of several 10^{-12} torr. Optimum lengths of the collector filament, for increasing the sensitivity, are given. The limiting pressure of the new gauge is equivalent or better than that of a Bayard–Alpert modulation gauge. A patented JG ionization gauge with shielded exterior collector operating without magnetic field and without modulation is described, with diagrams and sketches. Possible design improvements for better degassing are given. Author

N67-40161* Department of Agriculture, Washington, D. C. Economic Research Service.
WORLDWIDE USE OF AIRPHOTOS IN AGRICULTURE
Henry W. Dill, Jr. Sep. 1967 26 p refs *Its* Agr. Handbk. No. 344
(NASA Order R-09-038-001; NASA Order R-09-038-002)
(NASA-CR-89611) CFSTI: $3.00 CSCL 08B

The increasing use of aerial photography to provide data on agricultural production, inventory, planning, and development is reviewed. The major applications are identified as providing a base for field surveys, supplying information by stereo interpretations

of airphotos, and serving as a base for planning, administering, and recording agricultural programs. The scientific uses of airphotos are listed, and illustrative photographs are included. Worldwide airphoto coverage and uses are briefly described. N.E.N.

N67-40174# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
AN EQUATION FOR CHARACTERISTIC CURVES OF A SPECTROPHOTOMETRIC EMULSION
Thomas K. Krueger Jun. 1967 8 p refs
(ARL-67-0125; AD-658457)

An equation for the characteristic curves of photographic plates used in astronomical work is presented along with the procedure used to fit the experimental data to the equation. Its accuracy in calculating line intensities is discussed. Author (TAB)

N67-40176# Midwest Research Inst., Kansas City, Mo.
A STUDY OF THE ELECTRIC DEFLECTION OF MOLECULAR BEAMS Scientific Report
Frank T. Greene and Thomas A. Milne Aug. 1967 21 p refs
(Contract AF 49(638)-1724)
(AFOSR-67-1971; AD-658903)

A UHV molecular beam apparatus with a mass spectrometric detector, which is to be used for the measurement of dipole moments and polarizabilities was completed and is performing satisfactorily. The system, which is now undergoing final tests, is sufficiently sensitive to allow the study of species generated at pressures of less than 0.0001 torr. Author (TAB)

N67-40190# Aktiebolaget Atomenergi, Stockholm (Sweden).
CERENKOV DETECTORS FOR FISSION PRODUCT MONITORING IN REACTOR COOLANT WATER
O. Strindehag Sep. 1967 57 p refs
(AE-294) CFSTI: HC $3.00/MF $0.65

The expected properties of Cerenkov detectors when used for fission product monitoring in water cooled reactors and test loops are discussed from the point of view of the knowledge of the sensitivity of these detectors to some beta emitting isotopes. The basic theory for calculation of the detector response is presented, taking the optical transmission in the sample container and the properties of the photomultiplier tube into account. Special attention is paid to the energy resolution of this type of Cerenkov detector. For the design of practical detectors the results from several investigations of various window and reflector materials are given, and the selection of photomultiplier tubes is briefly discussed. The influence of the size and geometry of the sample container on the energy resolution follows from a separate investigation, as well as the relative merits of sample containers with transparent inner walls. Author

N67-40191# Naval Ordnance Lab., Corona, Calif.
A HIGH SPEED DIGITAL RECORDER FOR ATMOSPHERIC NOISE (SFERIC) WAVEFORMS
V. E. Hildebrand and D. A. Wulfing 15 Sep. 1967 28 p refs
(NOLC-739; AD-658722)

A high speed system for the digital acquisition of atmospheric noise (sferic) waveforms is described. System operation and reduction of data to obtain the amplitude and phase spectrums of the sferic impulse between 0.5 and 60.0 kHz are discussed. Author (TAB)

N67-40212# Mine Safety Appliances Co., Pittsburgh, Pa.
COLORIMETRIC PERSONAL DOSIMETER FOR HYDRAZINE FUELS Final Report, Jun. 1965–Aug. 1966
Charles A. Plantz Wright-Patterson AFB, Ohio, AMRL, May 1967 12 p refs
(Contract AF 33(615)-2929)
(AMRL-TR-66-162; AD-658442)

A research program was initiated to develop a personal colorimetric dosimeter for hydrazine fuels. An extensive literature survey was conducted to ascertain the most appropriate colorimetric reactions applicable to such a device. Many reagents were found which formed a color upon contact with various hydrazine vapors; however, most of these colored reaction products proved unstable during accelerated aging tests. Bindone, (delta 1,2 -- Biindan)--1, 3,3 -- Trione, uniformly dispersed on Eastman Chromagram Sheet (Type K301R2) was selected for incorporation as the sensing element in the dosimeter badge, because its response to hydrazine, unsymmetrical dimethylhydrazine (UDMH), and monomethylhydrazine (MMH) was both linear and readily observable. Synthetic color standards were developed and included in the dosimeter to provide the user with a means of estimating accumulated exposure within the range of 100-1800 ppm-minutes. Author (TAB)

N67-40255# Nuclear Corp. of America, Denville, N. J. Nuclear Div.
DEVELOPMENT OF A SEMIRAD DETECTION SYSTEM FOR HIGH-INTENSITY NEUTRON RADIATION
F. C. Riggin and H. J. Cooley 27 Jun. 1967 94 p refs
(Contract N228(62749)64869)
(NUCOR-031767; USNRDL-TRC-67-27; AD-658741)

The design, fabrication and testing of a detection system to measure pulses of high intensity neutron radiation is discussed. The system includes a neutron detecting component operating on the SEMIRAD principle and a stretcher amplifier component capable of accepting the output pulse from the detector, shaping and amplifying the pulse so that the time-integral of the pulse waveform is proportional to the neutron dose. The system was made to operate over the temperature range of -28C to +65C by modification of the detector design to permit constant vac-ion pumping even during burst time. This was considered necessary because of the hydrogenous liner outgassing as a result of elevated operating temperatures as well as the high intensity neutron pulses. The design goal of a unity gamma to neutron response ratio was achieved for fission spectrum neutrons. The amplifier itself generates a noise signal which is proportional to the incident burst yield and should be operated remotely from the detector (20 to 40 ft. cable lengths) and shielded if possible. Sufficient radiation hardness was demonstrated in the selection of amplifier components from exposure of one stretcher amplifier to a total dose of 26,600 rads with no detectable change in operability. Author (TAB)

N67-40295*# Harvard Coll. Observatory, Cambridge, Mass. Shock Tube Spectroscopy Lab.
A SIMPLE CLOSED–OPEN–CLOSED SPECTROGRAPH SHUTTER FOR EXPOSURE TIMES IN THE TEN MICROSECOND RANGE
G. L. Grasdalen, Martin Huber, and G. H. Newsom Aug. 1967 15 p refs
(Grant NsG-438)
(NASA-CR-89558; TR-5) CFSTI: HC $3.00/MF $0.65 CSCL 20F

A reliable and reproducible shutter is described, which was developed for use in quantitative absorption spectroscopy on pressure-driven shock tubes. The shutter is a free-flying piece held initially by two small bar magnets at a distance of 5.9 mm in front of the slit plane. In this position, its outermost portion occults the spectrograph slit. When the assembly is triggered, a wire explodes and a shock wave confined within a channel, drives the shutter in a direction normal to the slit length. At a certain time, the slot in the shutter will be aligned with the optical axis of the spectrograph. Further on it will again intersect the beam. After completely obstructing the light path, the shutter is stopped by a buffer. The frictionless motion of the shutter is cited as an obvious advantage. Shutter performance is dependent on the apparent

width of the grating, the distance from spectrograph slit to grating, and the distance between the slot in the shutter and the spectrograph slit. M.G.J.

N67-40296 Joint Publications Research Service, Washington, D. C.
AN AUTOMATED DESIGN SYSTEM
G. Goranskiy 20 Oct. 1967 8 p Transl. into ENGLISH from *Nauka i Tekhn. (Riga)*, no. 4, 1967 p 2–5
(JPRS-43042; TT-67-33667) CFSTI: $3.00

The man–machine interface is discussed in terms of the system approach to problems of automating design preparation of products. It is pointed out that such a system requires the mechanization and automation of information storage, search, and output; narrowly specialized information analysis and synthesis; supplementing the initial information; and making up design documentation and then duplicating it. Also considered is the methodology which includes the algorithms for the analysis, synthesis, and evaluation. An outline on the operation of such an automated system is included. M.G.J.

N67-40338# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DETERMINATION OF THE DISTORTION AND THE FOCAL LENGTH FOR THE OBJECTIVE-LENS OF THE CAMERA NAFA-3C/25 AND A CAMERA WITH A MOVING FILM [OPREDELENIYE DISTORSII I FOKUSNOGO RASSTOYANIYA OBBEKTIVOV NAFA 3C/25 I KAMERY PODVIKHNOY PLENKOY]
A. G. Kirichenko and A. A. Sychev 28 Feb. 1967 11 p refs Transl. into ENGLISH from Akad. Nauk SSSR. Astron. Sovet. Byul. Stantsiy Optich. Nablyudeniya Iskusstvennykh Sputnikov Zemli (USSR), no. 38, 1964 p 6–8
(Contract AF 33(657)-14782)
(FTD-HT-67-86; TT-67-62937; AD-658767)

A study of the distortion of camera objectives was made to determine the suitability of photographs taken with the KPP and NAFA-3c/25 cameras for precise astrometric work. The stars used in the determination of distortion were at distances of 8-11 degrees from the optical center for the NAFA-3c/25 camera and 5-15 degrees from the optical center of the KPP camera. Mean distance between reference stars was 3-5 degrees. Much of the description of the method of analyzing the data presumes that the reader has a knowledge of the Kiselev method described in the above-cited reference. Difficulties are involved in the study because with the NAFA-3c camera it is possible to obtain a photograph with a satellite trail not far from the optical center, but this cannot be done with the KPP camera; in the latter case the points to be measured are always at some distance from the optical center or even at the margin of the frame. Coordinates were computed on a Ural-2 computer. Data are given on objective distortion and the dependence of the distortion coefficient on distance of the object from the center of the photograph. Information is also presented on the dependence of the distortion coefficient on azimuth for the two cameras. An important discovery was that the distortion is asymmetrical relative to the optical center. Focal length was determined from a zenith photograph of stars with a good point image; star pairs were selected so that the straight line passing through the pair intersected the center of the photograph. TAB

N67-40388# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SPIN GENERATOR [O SPINOVOM GENERATORE]
N. M. Ivevskaya and R. M. Umarkhodzhayev 5 May 1967 25 p refs Transl. into ENGLISH from Elektrichestvo (Moscow), no. 7, 1965 p 57–64
(FTD-HT-66-470; TT-67-62913; AD-658652)

Theoretical and experimental investigations of a spin generator show that this type of instruments can find and is finding application in the various fields of science and technology where it is necessary to make an accurate tracking of the intensity of a constant magnetic field: in magnetometers, is constant magnetic field stabilizers, and also in spectrometers of nuclear magnetic resonance. The use of a spin generator in magnetometry permits continuous control over field intensity changes which has an unconditional advantage in comparison with the free precession method. The use of a spin generator for measuring and stabilizing a constant magnetic field intensity in comparison with the use of a passive line of nuclear magnetic resonance increases the attainable accuracy, since the stability of a spin generator is considerably higher than $1/Q$ where Q is the quality of a passive line of nuclear magnetic resonance. Author (TAB)

N67-40398*# National Research Corp., Cambridge, Mass.
EXTENSION OF GAGE CALIBRATION STUDY IN EXTREME HIGH VACUUM (ORBITRON AND MAGNETRON STUDIES)
F. Feakes, E. C. Muly, and F. J. Brock Washington, NASA, Oct. 1967 153 p refs
(Contract NASw-1137)
(NASA-CR-904) CFSTI: HC $3.00/MF $0.65 CSCL 14B

Continuing efforts to develop more reliable and higher sensitivity pressure gages for pressures below 10^{-10} Torr are reported. Consideration is given to the orbitron gage, which has a high potential for measuring extremely low pressures and also for performing aerospace pressure measurements. A method was developed for obtaining a self-consistent solution for the electron motion, charge density distribution, and space charge dependent potential distribution in an orbitron. A normal magnetron gage is also described. Major emphasis was on the measurement of the sentivities of a magnetron gage over wide ranges of anode voltages, magnetron field strengths, and pressures. A study was made of the rf oscillatory behavior of the normal magnetron gage. The generation of stable rf frequencies could not be detected below 2×10^{-10} Torr—the pressure below which the gage is nonlinear. A number of photographs of the discharge inside the experimental magnetron gage were taken. From these it was possible to estimate the shape of the discharge and its intensity. Effects of pressure, anode voltage, and magnetic field strength on the discharge were broadly examined. S.P.

N67-40402# Milletron, Inc., Pittsburgh, Pa.
WIDE RANGE DIGITAL NUCLEAR INSTRUMENTATION CHANNEL: PHASE I STUDY
M. A. Schultz, T. Matty, and E. Kenney 30 May 1967 97 p refs
(Contract AT(30-1)-3738)
(NYO-3738-7) CFSTI: HC $3.00/MF $0.65

The results of the Phase I study program undertaken in conjunction with the ultimate design, construction, and evaluation of a wide range digital reactor measurement channel are presented. The system will monitor and display reactor power levels as well as the rate-of-change of power level. NSA

N67-40482# Atomic Power Development Associates, Inc., Detroit, Mich.
POTENTIAL APPLICATIONS FOR AN UNDER-SODIUM ULTRASONIC SCANNING DEVICE
C. C. Scott, P. R. Huebotter, and R. C. Callen Jul. 1967 38 p refs
(Contract AT(11-1)-865)
(APDA-205) CFSTI: HC $3.00/MF $0.65

Previous AEC-sponsored development work on various concepts of under-Na scanning devices has resulted in the selection of a single approach that represents the best compromise of simplicity, flexibility, range, and resolution. In the context of the capabilities and limitations of this approach, which employs a narrow-beam ultrasonic transducer with a metallic focusing lens operable in Na

at 600°F, numerous applications in existing and future Na-cooled reactors and associated research and development projects are possible. A survey of these applications has been made, evaluated, and reduced to a single demonstration objective which represents a common denominator of most of the applications of greatest potential interest in the Liquid Metal Fast Breeder Reactor development program. This demonstration, which could be first pursued in an out-of-pile mockup facility and then be followed by a demonstration in an existing Na-cooled reactor, is defined as the recommended near-term goal for a follow-on development effort. Author (NSA)

N67-40518# Hauptverband der Gewerblichen Berufsgenossenschaften, E. V., Bonn (West Germany). Staubforschungsinstitut.
PORTABLE INSTRUMENTS FOR INDUSTRIAL DUST MEASUREMENTS
Wilfried Coenen *In* Israel Program for Sci. Transl. Hygiene Effects and Control of Dusts, Fogs, Gases, Vapors, Radioactive Particles [1966] p 9–14 refs (See N67-40516 24-34)

For assessing hygienic conditions of a working place measurement of dust concentration in the breathing region of an operator is required. This can only be achieved by portable measuring instruments if work is carried out in various sites. Different individual measuring instruments, using the gravimetric method, are described and compared technically, particularly their air flow rate. The high-airflow rate instrument developed is also described and its application in industry is explained by examples. Author

N67-40530# Ballistic Research Labs., Aberdeen Proving Ground, Md.
METHODS FOR INSTALLING THE IBL MINIATURE PRESSURE GAGE
Emerson V. Clarke, Jr. and Robert W. Deas Aug. 1967 25 p refs
(BRL-TN-1662; AD-658999)

The detailed drawings in this report specify the required modifications to cartridge cases and gun tube walls to allow installation of IBL Miniature Pressure Gages. Additional information is included in the descriptive text to provide instructions for the assembly and installation of components. Recommendations are made which must be followed to make precise measurements with these gages. Author (TAB)

N67-40556# Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
CHARACTERISTICS OF A PROTON-RECOIL PERLOW SPECTROMETER [CARATTERISTICHE DI UNO SPETTROMETRO PERLOW A PROTONI DI RINCULO]
M. Marseguerra and C. M. Porceddu 1966 16 p refs In ITALIAN; ENGLISH summary
(RT/FI/66/36) CFSTI: HC $3.00/MF $0.65

Utilization of a proton-recoil Perlow-type neutron spectrometer for continuous spectral measurements is analysed. When the system and the pulse size distribution due to monoenergetic radiation are simulated by a Monte Carlo code, the results are found to be in good agreement with previous calibrations made at the Padua Van de Graaff accelerator. Author

N67-40568*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A SMALL VOLUME, ULTRAHIGH VACUUM SYSTEM FOR IONIZATION GAGE STUDIES
R. A. Outlaw and James M. Bradford, Jr. Washington, NASA. Nov. 1967 20 p refs
(NASA-TN-D-4208) CFSTI: HC $3.00/MF $0.65 CSCL 14B

A small ultrahigh vacuum system has been developed for use in the research and development of ionization gages capable of ultrahigh vacuum measurements. The system operates at estimated pressures of less than 5×10^{-13} torr (66.5 pN/m^2). These pressures are obtained by a combination of gage and cryogenic pumping and a rigorous baking procedure. The system was specifically designed for study of magnetron ionization gage characteristics, but can be used additionally to study any low outgassing device small enough to fit in the system. A presentation is made of the details of the system and of the techniques used for obtaining the low pressure. A discussion of the pressure measurement techniques is given and calculations are shown which estimate the ultimate pressure obtained by the system. Author

N67-40574*# Aero Vac Corp., Troy, N. Y.
DESIGN AND FABRICATION OF A HYDROGEN DETECTION CALIBRATION SYSTEM Final Report
8 Sep. 1967 26 p refs
(Contract NAS8-11999)
(NASA-CR-89656) CFSTI: $3.00 CSCL 14B

The system consists of a vacuum chamber, mechanical vacuum pump and valving, an environmental heating and cooling system, and a gas admittance, flow measurement and quantitative gas calibration system. The equipment has a capability of admitting and measuring hydrogen, air, and oxygen in quantities of 100 ppm to 15% hydrogen in air or oxygen over a pressure range of 0.1 torr to 760 torr in the vacuum chamber. The environmental heating and cooling system controls vacuum chamber temperature between −120°C to +77°C. All motors and electrical control boxes are explosion proof. Design and safety considerations are reviewed. Explosive testing of the vacuum vessel is described in detail. A complete set of operating instructions is presented which includes a general description, safety provisions, chamber and pumping system, environmental heating and cooling, control and instrumentation systems, operating procedures, maintenance, and a spare parts listing. E.C.

N67-40592# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
VARIATION OF THE γ-RAY RESOLUTION OF Ge(Li) DETECTORS WITH THE POSITION OF IRRADIATION [VARIATION DE LA RESOLUTION PAR RAYONS GAMMA DES DETECTEURS AU Ge(Li) SELON LA POSITION DE L'IRRADIATION]
M. G. Chartrand and H. L. Malm Jun. 1967 28 p refs
(AECL-2764) CFSTI: HC $3.00/MF $0.65

A study was made of the γ-ray energy resolution of planar Ge(Li) p-i-n detectors showing varying degrees of charge trapping. A small area collimated beam of ^{51}Cr (320 keV) γ-rays was used to irradiate the detectors both parallel and perpendicular to the junction surfaces. (For some measurements a ^{137}Cs source (662 keV) was also used). Three detectors, from different crystals, were studied in detail. To identify the carrier being trapped, the beam was directed parallel to the junctions and was moved from one junction to the other. The three detectors exhibited the best resolution and the maximum pulse height when irradiated adjacent to the n^+-i boundary, indicating predominantly electron trapping. For example, with one detector, the detector contribution to the resolution $(\Delta E)_D$ varied from 1.9 keV at the n^+-i junction to 8.7 keV at the i-p junction ($E\gamma$=320 keV). Considerable variation of resolution with position was also observed when a 2 mm diameter beam was directed perpendicular to the junction surface. With one detector, $E\gamma$=320 keV), $(\Delta E)_D$ varied from 1.7 to 10.7 keV indicating considerable inhomogeneity in the distribution of trapping centers. Counts of the etch pit density made on one detector showed no correlation with the variations in energy resolution. Author

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

N67-39386# Naval Ship Research and Development Center, Washington, D. C.
VIBRATION TRANSMISSION STUDIES OF FLEXIBLE PIPE CONNECTIONS
Ronald C. Hirsch Aug. 1967 24 p refs
(NSRDC-2441; AD-657848)

The results of studies of vibration transmission on three sizes of pressurized and unpressurized flexible pipe connections are presented. The connections include Dacron-lined and steel-braided hoses in dog-leg configurations and Electric Boat flexible pipe couplings in three-planar configurations. Results showed that, generally, the Dacron-lined hoses exhibited lower vibration transmission characteristics than did the steel-braided hoses and Electric Boat flexible couplings. However, the Dacron-lined hoses showed a larger increase in vibration transmission between 20 and 800 hertz when pressurized, than did the other types of flexible connections in the same frequency range. Results also showed that little difference existed between the magnitudes of transfer impedance for the three sizes of unpressurized Dacron-lined flexible hose. Author (TAB)

N67-39396# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MACHINING REFRACTORY AND RARE-EARTH METALS. SECTION V
A. M. Daniyelyan, P. I. Bobrik, Ya. L. Gurevich, and I. S. Egorov 2 May 1967 90 p refs Transl. into ENGLISH from the Publ. "Obrabotka Rezaniyem Zharoprochnykh Staley, Splavov I Tugoplavkikh Metallov" Ukrania, 1965 p 212–308
(FTD-MT-65-584; TT-67-62869; AD-658385)

The article deals with machining of rare earth and refractory metals. Physical-mechanical and chemical properties are discussed. Methods of machining, treatment, types of cutters, and safety procedures for various metals are described. Author (TAB)

N67-39470# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
ON DEGRADATION OF COMBINATION LOCKS AND THE MAXIMUM TIME TO OPEN THEM
Mary D. Lum *In its* Blanch Anniv. Vol. 21 Feb. 1967 p 189–213 *ref* (See N67-39461 24-19)

The performance of excellent locks is described quantitatively (numerically) and compared with deteriorated or cheaply made new locks, using the maximum time through trial and error to arrive at the correct combination for opening the lock. Two trial procedures are discussed: L-time, where all three tumblers must be dialed in proper consecutive sequence; and S-time, where a shortcut procedure can be used for older type locks. Consideration is also given to randomization under various restrictions, and statistical properties dependent on trial-order of marker settings. Mathematically, two cases are examined: the balanced case where the number of possible third-number trials per first-two-numbers trial is constant; and the unbalanced case, where the number of possible third-number trials per first-two-numbers trial depends upon combination trial order. Formulas are derived for calculating maximum, minimum, and average S- and L-times, and for S-times in the unbalanced case. In addition, the statistical implications of the problem are investigated, with the validity of the maximum time evaluated as a criterion for measuring performance in the unbalanced case. M.G.J.

N67-39521* IIT Research Inst., Chicago, Ill. Technology Center.
INVESTIGATION OF INTERFACE FRICTION BETWEEN TOOL AND WORKPIECE MATERIALS UNDER CONDITIONS OF PLASTIC DEFORMATION Final Report, 1 Apr. 1966–31 Jul. 1967
John A. Newnham and John A. Schey 31 Aug. 1967 93 p refs
(Contract NOw-66-0503-d)
(IITRI-B6083-6; AD-657817)

An investigation was carried out on interface friction between workpiece and die material under conditions of plastic deformation. Evaluation was made by means of two simulating tests: a twist-compression technique provided conditions of enforced sliding, whereas in ring upsetting experiments sticking friction was predominant. Hot rolling tests were performed in order to correlate the results with conventional metalworking practice. 7075 Al, Ti-6Al-4V, 4140 steel, TZM, and Hastelloy X were used as workpiece materials. These were deformed with tools of H12, 4140, WC, Al2O3-coated H12, boronized 4140, chromized 4140, and titanium carbide-coated 4140. Significant variations in friction due to die surface composition were observed, the effects being more marked with enforced interface sliding. The most promising anvil material from both frictional and mechanical aspects was boronized 4140. Good correlation with existing theories of adhesion was obtained, although these theories did not fully account for the observed effects of workpiece hardness and alloy composition. The presence of a surface oxide on the workpiece reduced the friction in elevated temperature tests with all materials except Hastelloy X, the oxide of which had no effect on friction under the conditions investigated. Author (TAB)

N67-39628# Naval Air Engineering Center, Philadelphia, Pa. Aeronautical Materials Lab.
DEVELOPMENT OF A POSITIVE STOP-LOCKING DEVICE FOR INCORPORATION IN FLARELESS FITTINGS
A. Bold 7 Jun. 1967 18 p refs
(NAEC-AML-2621; AD-657856)

A new type flareless fluid connector, in which the nut bottoms against the union face, was designed to eliminate the use of tightening torque values, reduce the vibration stress level in union, and reduce union, nut and sleeve deformations during repeated installations. Author (TAB)

N67-39643# Carnegie Inst. of Tech., Pittsburgh, Pa. Management Sciences Research Group.
STATISTICAL ESTIMATION IN A PROBLEM OF SYSTEM RELIABILITY
D. P. Gaver and M. Mazumdar (Westinghouse Elec. Corp., Pittsburgh, Pa.) Feb. 1967 40 p refs Prepared in cooperation with Westinghouse Electric Corp.
(Contract Nonr-760(24))
(RR-89; AD-648085) CFSTI: HC$3.00/MF$0.65

The statistical estimation of the reliability of a simple system, subject to exponential failures and subsequent repairs, is considered. Observations are assumed taken at isolated instants (snapshots), and for also continuous periods of time (patches); the information is combined by maximum likelihood. Procedures for improving small-sample properties of estimates are studied by Monte Carlo sampling experiments. The robustness of the estimates is similarly considered. Author (TAB)

N67-39648# Defense Dept., Washington, D. C.
PROCEEDINGS DEFENSE CONFERENCE ON QUALITY AND RELIABILITY MANAGEMENT, VOLUME I
Aug. 1966 63 p Conf. held in Annapolis, Md., 2–4 Aug. 1966
(AD-648315) CFSTI: HC $3.00/MF $0.65

The purpose of the symposium is to determine those objectives, concepts, policies and uniform procedures essential to effective quality and reliability management within the Department of Defense. Author (TAB)

N67-39681# Los Alamos Scientific Lab., N. Mex.
FABRICATION OF CERAMIC COMPONENTS FOR USE IN PLUTONIUM ELECTROREFINING
S. D. Stoddard and D. E. Nuckolls 1 Aug. 1967 9 p refs
(Contract W-7405-ENG-36)
(LA-3707) CFSTI: HC $3.00/MF $0.65

A method of fabricating ceramic cells and associated components for use in the electrolytic refining or electrowinning of Pu metal is described. Details for making such ware of impervious Al_2O_3 and MgO are described. References on the development of processes for the electrochemical preparation of up to 3.5 kg per batch of Pu and the ceramics required for such processes are also given. Author (NSA)

N67-39681# Rocky Flats Div., Dow Chemical Co., Golden, Colo.
METALLOGRAPHIC TECHNIQUES FOR VACUUM-CAST ROLLED INGOT BERYLLIUM SHEET
Arthur E. Calabra and Ross J. Jackson 7 Aug. 1967 10 p refs
(Contract AT(29-1)-1106)
(RFP-962) CFSTI: HC $3.00/MF $0.65

Two techniques developed for the metallographic preparation of vacuum-cast ingot Be sheet are described. Both methods yield metallographically prepared surfaces considered to be of the highest quality. The first method retains inclusions and requires polarized illumination for structural delineation. The second method is an electrolytic swab-etch technique, which yields bright-field delineation of the microstructure; however, inclusions are not retained. Effects that improper preparation can have on the resulting microstructure are considered. Author (NSA)

N67-39744# Bureau of Mines, Pittsburgh, Pa.
THE CAUSE OF FUMING IN OXYGEN STEELMAKING
J. P. Morris, J. P. Riott, E. G. Illig, and R. H. Jefferson (Bur. of Mines, Minneapolis, Minn.) Nov. 1967 30 p refs
(BM-RI-7047)

Reported is a study on the mechanics of fuming of iron–carbon melts during top-blowing with oxygen. Melts weighing 45 lb were prepared in an induction furnace and blown with oxygen by means of water cooled lances. The rate of fuming was measured and correlated with the operating variables. Data showed that the primary cause of fuming was a boil at the bath surface in the impingement zone of the oxygen jet. Nucleation of the carbon monoxide bubbles producing the boil was induced by the precipitation of an oxide phase. The fuming mechanism invcived partial oxidation and vaporization of bubble films and fine metal spray generated by the bursting of the bubbles. Bubbles that formed outside the impingement zone produced little fume. The distribution of trace elements between the metal and fume strongly indicated that the fume contained fine spray particles as well as particles that had condensed from vapor. The rate of fuming was found to be proportional to the carbon content of the metal, the concentration of oxygen in the jet, and the bath temperature, provided that a continuous boil occurred. In the absence of a boil, little fume was produced. Author

N67-39798* Mobil Oil Corp., Paulsboro, N. J. Research Dept.
MICROFOG LUBRICANT APPLICATION SYSTEM FOR ADVANCED TURBINE ENGINE COMPONENTS. TASK I: THEORY, EQUIPMENT, AND EXPERIMENTAL APPROACHES TO PRINCIPAL VARIABLES
J. Shim and S. J. Leonardi 29 Sep. 1967 70 p refs
(Contract NAS3-9400)
(NASA-CR-72291) CSCL 11H

A test apparatus for the determination of critical properties of lubricants as microfogs is described. The test rig provides a range of conditions such as might be encountered in a "once through" lubrication system for high speed aircraft engines, and will measure the velocities and size distributions of microfog streams and the rates at which they wet a solid surface at elevated temperatures. Key considerations in designing a microfog lubricant application system are discussed from practical and theoretical points of view. Author

N67-39861*# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
DEVELOPMENT OF A SYSTEM FOR PRESTRESSING BRITTLE MATERIALS Final Report
L. B. Greszczuk and H. Leggett Aug. 1967 188 p refs
(Contract NAS7-429)
(NASA-CR-89607; DAC-92200) CFSTI: $3.00 CSCL 13H

The concept of internally prestressing chemically consolidated zirconia with tungsten cable to increase flexural and tensile load-carrying ability of the ceramic at room and elevated temperature has been demonstrated. Stress at failure, taken as the stress at which the initial crack in the ceramic occurred, was increased four-fold in flexure and eight-fold in tension. A theory whereby the strength of the composite is predicted from the properties of the constituents was developed for estimating the initial and ultimate strengths of the developed composites. Experimental data obtained in this program demonstrated the validity of the developed theory. Analytical trade-off studies were also conducted on the strength of composites incorporating various combinations of matrix (ceramic) and reinforcement materials. These trade-off studies were used to rate the efficiency of these composites at room and elevated temperatures, and also to select the ceramic and reinforcement to be used in this program. The two materials chosen for study, tungsten cables and chemically consolidated zirconia, were characterized for mechanical and physical properties at room and elevated temperatures. Author

N67-39884# Jessop-Saville, Ltd., Sheffield (England)
THE PRODUCTION AND EVALUATION OF THE PROPERTIES OF TITANIUM ALLOY CASTINGS
A. Dunlop and H. C. Child London, Min. of Tech., Mar. 1967 35 p
(Contract KS/1/0157/CB.43(a)2)
(S&T-MEMO-2/67; AD-658750)

A consumable electrode vacuum arc melting procedure using a skull melting and pouring device produced satisfactory titanium castings. Centrifugal casting gave improved definition and surface finish to the castings. A ceramic shell moulding technique based on the lost wax process produced castings with good surface finish and accuracy, and with little surface contamination. Satisfactory castings were produced in a range of titanium alloys with tensile strengths in the range 28-55 tons/sq in. A pouring technique using consumable electrode vacuum arc furnace and copper and graphite crucibles sealed with a titanium plug which eventually melted to effect pouring was not satisfactory. Author (TAB)

N67-39913# California Univ., Livermore. Lawrence Radiation Lab.
INTERNATIONAL STATUS OF THERMAL ERROR RESEARCH

James B. Bryan 3 Jul. 1967 25 p refs Presented at the 17th Gen. Assembly of CIRP, Ann Arbor, Mich., Sep. 1967
(UCRL-50285) CFSTI: HC $3.00/MF $0.65

A cooperative effort of the new CIRP Subgroup formed to deal with the overall problem of thermal effects errors in machine tools and metrology is described. The thermal effects problem is summarized by a diagram which is intended to show all possible forms of thermal error. Existing research literature and the need for new work is reviewed in terms of this diagram. Author (NSA)

N67-39927# Heil Scientific Labs., Inc., Belmont, Calif.
PARTICLE BOMBARDMENT BONDING AND WELDING INVESTIGATION Final Report, 15 Dec. 1964–15 Mar. 1967
Oskar Heil 1967 170 p refs
(Contract DA-28-043-AMC-00429(E))
(ECOM-00429-F; Rept.-8; AD-658685)

Particle bombardment chemistry and thermal chemistry are compared. Particle bombardment techniques for crystal growth welding and bonding are discussed. The nine different sputter arrangements used in this study for producing ion bombardment bonded coatings are described. All of them use high frequency energy for plasma generation and most of them utilize magnetic plasma confinement. Combinations of the following insulating materials and metals have been particle bombardment bonded, vacuum brazed or pressure sealed and tested for tensile strength. Insulating Materials: Al2 O3 (Al 995, CE 988, WESGO, Lucalox, G.E); BeO (Thermalox Brush-Beryllia); Si O2 (Quartz, Vicor); Glass 1723 (Corning); Pyroceram (Corning) and also Ferrites. Primary Metals: Zr, Ti, V, Nb, Ta, Mo, W, Al and Alloys: Molybden-Tungsten (50%), Stainless Steel (304), Nichrome (18% and 35% Cr.) and Kanthal. Secondary Metals: Cu, Ag, and Au. Tensile Strength Results are tabulated for all tests. TAB

N67-39928# Mechanical Technology, Inc., Lathan, N. Y.
A SEMI-IMPLICIT NUMERICAL METHOD FOR TREATING THE TIME TRANSIENT GAS LUBRICATION EQUATION
Vittorio Castelli and Charles H. Stevenson Mar. 1967 17 p refs
(Contract Nonr-3730(00))
(MTI-67TR14) CFSTI: HC $3.00/MF $0.65

A numerical method is presented for treating the time transient Reynolds equation which has the numerical stability properties of implicit schemes and the speed of execution of explicit methods. These advantages make this method quite suitable for both steady-state and transient calculations. Author (NSA)

N67-39962*# IIT Research Inst., Chicago, Ill. Technology Center.
MATERIAL PREPARATION AND INSTRUMENTATION FOR WELDING S-1C COMPONENTS Final Report, May 1966–Jun. 1967
20 Sep. 1967 288 p refs
(Contract NAS8-20363)
(NASA-CR-89608; IITRI-B6065-15) CFSTI: HC $3.00/MF $0.65 CSCL 13H

Aluminum alloy surfaces were examined by optical reflectance, mass spectrometry, gas chromatography, spark emission spectroscopy, radioactive tracer, and light and electron microscopy techniques. The methods of surface analysis were used in conjunction with a spot weld test to identify and measure the surface conditions that create defects in welds. Surface contamination, including adsorbed liquids and vapors and the oxide layer, was found to be a major source of weld defects. Conventional surface preparations of chemical cleaning, solvent degreasing, wire brushing, and scraping, contaminate the surface and produce a high defect potential. A machined surface has a low defect potential and must be protected or stored in dry air to preserve this potential. Spark emission spectroscopy was the best method for the chemical analysis of surface contamination and scanning electron microscopy the most suitable for revealing the physical nature of contaminated surfaces. The results of the spot weld tests were confirmed in butt-welded panels. Author

N67-39986*# Chrysler Corp., New Orleans, La. Space Div.
TEST REPORT FOR 8-INCH CHECK VALVE MISSION VALVE AND PUMP COMPANY PART NUMBER 15 CPF-311 NASA DRAWING NUMBER 75M17763 HCV-9
Patrick D. M. Rogan 18 Aug. 1967 64 p
(Contract NAS8-4016)
(NASA-CR-89769; TR-RE-CCSD-FO-1110-3F) CFSTI: $3.00 CSCL 13K

This report presents the results of the tests performed on one specimen of an 8-inch check valve. The specimen successfully completed the tests but failed to meet functional leakage requirements. Internal leakage rates were consistently above the maximum allowable leakage rate of 40 sccm during the test program. Following installation of the Teflon-coated leaf pin and Teflon washers, the cracking pressure was within or below the specified range of 0.15 psig ±20 percent. Author

N67-39988* Chrysler Corp., New Orleans, La. Space Div.
TEST REPORT FOR ANGLE VALVE, 3/8-INCH JAMES, POND, AND CLARK INC., PART NUMBER BR949T1-6BB(T9) NASA DRAWING NUMBER 75M09618 PAV-2
G. Collins 6 Jul. 1967 78 p
(Contract NAS8-4016)
(NASA-CR-89778; TR-RE-CCSD-FO-1115-3) CSCL 13K

This report presents the results of tests performed on one specimen of an angle valve. The specimen's performance was in accordance with specification requirements except during the cycle test. After 143 cycles the torque required to operate the valve exceeded the 10 foot-pounds seating and the 5 foot-pounds running torque. Disassembly of the valve revealed damaged threads on the valve stem and failure of the packing gland. The valve was sent to the vendor for reworking, and after its return was retested. Results of the second cycle test were satisfactory. Author

N67-39989*# Chrysler Corp., New Orleans, La. Space Div.
TEST REPORT FOR CHECK VALVE 1/2-INCH, SPRING-POPPET JAMES, POND, AND CLARK PART NUMBER 220T6-8TT-3 NASA PART NUMBER 75M12944 FCV-9
G. Collins 22 Aug. 1967 66 p
(Contract NAS8-4016)
(NASA-CR-89774; TR-RE-CCSD-FO-1080-3) CFSTI: $3.00 CSCL 13K

This report presents the results of tests performed on one specimen of a check valve. The specimen performance was in conformance with specification requirements except for the initial functional test. Test requirements specify 3 psig cracking pressure during the functional test. The test specimen cracked at zero psig and also reseated at zero psig. The valve was returned to the vendor for reworking. The average cracking pressure after the vendor reworked the valve was 1.85 psig. This was accepted and testing was continued. Author

N67-40068# Defense Dept., Washington, D. C.
PROCEEDINGS DEFENSE CONFERENCE ON QUALITY AND RELIABILITY MANAGEMENT, VOLUME II
Aug. 1966 249 p refs Conf. held in Annapolis, Md., 2–4 Aug. 1966
(AD-648316) CFSTI: HC $3.00/MF $0.65

The purpose of the symposium is to determine those objectives, concepts, policies and uniform procedures essential to effective quality and reliability management within the DoD. Author (TAB)

N67-40077# Massachusetts Inst. of Tech., Cambridge.
INCREASING ELECTROCHEMICAL MACHINING RATES Final Report
Nathan H. Cook, Stephen P. Loutrel, and Michael C. Meslink Army Mater. Res. Agency, Watertown, Mass., 16 Jan. 1967 124 p refs
(Contract DA-19-066-AMC-268(W))
(AMRA-GR-67-03(F); AD-659004)

Phenomena which may limit the rate of Electro-Chemical-Machining (ECM) are postulated, and indirectly studied by attempting their elimination. Of the mechanisms studied, three appear most promising: (1) Elevated electrolyte pressure in the ECM zone reduces boiling, cavitation, and formation of hydrogen bubbles. As a result, drilling rates of 1.5 in/min have been attained at current densities up to 19,700 amps/sq in. This can be compared with a typical maximum rate of 1/4 in/min. (2) The use of fused salt electrolytes (such as NaOH) appears quite promising for difficult-to-ECM materials such as tungsten-carbide. (3) Pulsed Dc current with short reverse spikes appears promising for materials such as tungsten-carbide which normally form relatively impervious reaction layers. Author (TAB)

N67-40085# Union Carbide Corp., Oak Ridge, Tenn. Nuclear Div.
IDENTIFICATION OF A NUMERICALLY CONTROLLED MACHINE TOOL SERVO LOOP
R. V. Miskell 21 Aug. 1967 73 p refs
(Contract W-7405-ENG-26)
(Y-1586) CFSTI: HC$3.00/MF$0.65

A Pseudo Random Binary Sequence (PRBS) signal was used to obtain the closed loop transfer function of a precision continuous path numerically controlled (NC) machine tool/control system. The study substantiates the use of the PRBS as a means of determining the frequency response of NC machines, and justifies further investigation into the use of the PRBS in the identification element of an adaptive control system. Author (NSA)

N67-40093* Avco-Everett Research Lab., Everett, Mass.
EXPERIMENTS WITH MAGNETOHYDRODYNAMICALLY SUPPORTED SHOCK LAYERS
E. Locke, H. E. Petschek, and P. H. Rose Jul. 1964 36 p refs
(Contract NASw-748)
(NASA-CR-89648; Avco-Everett Res. Note-460) CSCL 20I

Shock tube experiments have been performed to quantitatively determine the interaction of a hypersonic flow with the magnetic field of a straight current-carrying wire oriented perpendicular to the flow direction. The interaction takes place in a thin layer behind the detached shock wave. Most of the experimental work was performed in a 50–50 mixture of argon and oxygen, at an initial pressure of 1 mm Hg, and in a range of shock velocities between 4.3 and 8 mm/μsec. Data have been obtained by observing the flow luminosity, using an image converter and mirror camera looking both perpendicular to and along the wire. A circular shock front was observed to stand up to 5-1/2 cm in front of a 1 cm radius cylinder producing the magnetic field. The data on shock position vs current were in excellent agreement with theory in spite of the fact that values of ϵ equal to 0.25 resulted in theoretical accuracies only to within a factor of two. Author

N67-40194* Harvey Aluminum, Torrance, Calif. Harvey Engineering Labs.
DEVELOPMENT OF CONTROLS FOR TIME-TEMPERATURE CHARACTERISTICS IN ALUMINUM WELDMENTS Final Report
D. Q. Cole Oct. 1966 150 p
(Contract NAS8-11930)
(NASA-CR-89621; HA-2283) CFSTI: $3.00 CSCL 13H

For current aerospace applications, it is necessary to improve the properties of weldments in aluminum plate by controlling time-temperature relationships during the welding operation. An experimental study was conducted to determine the effects of controlling this relationship by employing a concept for chilling the weldment simultaneously with welding by impingement of liquid CO_2 jets in the vicinity of the weld. Results indicate that this concept is feasible, producing substantial increases in yield strength and reducing distortion markedly. It is also indicated that gross porosity can be reduced. Technical background, experimental procedures, and analysis of results are presented. Author

N67-40219* Chrysler Corp., New Orleans, La. Space Div.
GLOBE VALVE, 1/2-INCH GROVE VALVE AND REGULATOR COMPANY PART NUMBER 11193A046B NASA DRAWING NUMBER 10428576 Test Report
G. Collins 27 Jun. 1967 57 p
(Contract NAS8-4016)
(NASA-CR-89687; TR-RE-CCSD-FO-1123-3) CSCL 13K

Results of the following tests performed on one specimen of a valve are reported.: receiving inspection, proof pressure, functional, flow, surge, low temperature, high temperature, life cycle, and burst. During burst testing, the valve failed at 15,000 psig. The specification requirements were that the valve withstand a minimum burst pressure of 24,000 psig. Author

N67-40258# Franklin Inst., Philadelphia, Pa.
ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS INTO THE STABILITY CHARACTERISTICS OF GAS-LUBRICATED TILTING-PAD JOURNAL HEARINGS
John T. Mc Cabe and Otto Decker Durham, N. C., Army Res. Office, Apr. 1967 37 p refs Presented at the Univ. of Southampton Gas Bearing Symp., Apr. 1967 *Its* Paper No. 17
(Contract DA-31-124-ARO(D)-147)
(AROD-4372-2; AD-657538)

The gas-lubricated tilting-pad journal bearing has been successfully developed to meet the requirements imposed by ground-based and space-power machinery. Satisfactory performance in applications such as gas circulators, Brayton cycle turbocompressors and turboalternators, and many others is a direct consequence of the well balanced analytical and experimental programs conducted both in the U.S.A. and the U.K. Experience indicates that prediction of steady-state performance only, however accurate, is insufficient to provide adequate insight into actual machine operation or to minimise hardware development problems. Dynamic performance, in terms of the interactions between rotor, bearings, and bearing-support system, must be carefully evaluated as part of the analytical procedure and the results filtered into the final design. In addition, the influence of pibot configuration, pre-load, materials, etc., must be established and carefully incorporated into each application. Author (TAB)

N67-40261* General Electric Co., Philadelphia, Pa. Missile and Space Div.
DEVELOPMENT OF ENERGY DISSIPATING PLASTIC HONEYCOMB Quarterly Progress Report No. 7 and 8, 1 Feb.–31 Jul. 1967

1 Aug. 1967 114 p Prepared for JPL
(Contracts NAS7-100; JPL-951172)
(NASA-CR-89646; DIN-66SD4390) CSCL 13H

Fabrication and testing of dovetail honeycomb specimens is discussed. A dovetail curing fixture was fabricated, used successfully, improved, and reused to form a total of three hemispherical specimens. An R/t ratio of approximately 1.8 was achieved. Static tests of one hemispherical specimen were satisfactory. The program included fabrication of 20×20×10 inch tool-formed dovetail logs, disk-type impact limiters, and additional hemispherical shells. Four of the fabricated disk-type impact limiters were attached to a simulated payload. These landers were designed for high-velocity impact landing tests. Cutting and bonding procedures were established which resulted in satisfactory performance of the landers. Hexagonal-cell plastic honeycomb was used for these fabrications. An analysis was performed to define the geometric changes of an impact limiter on a cylindrical lander and to define the effective moment arm as a function of the depth of crush-up and the angle of impact. This analysis helps to determine deceleration and crushing depth of the limiter during landings at various orientations of the lander with respect to the landing surface. K.W.

N67-40283 Joint Publications Research Service, Washington, D. C.
FORGING OF REFRACTORY METALS IN A VACUUM
S. B. Pevzner, N. I. Korneyev, I. G. Skugarev, A. S. Tugushev, Yu. V. Malashenko et al 18 Oct. 1967 5 p refs Transl. into ENGLISH from Tsvetn. Metal. (Moscow), no. 8, Aug. 1967 p 86–88
(JPRS-43015; TT-67-33640) CFSTI: $3.00

Details are given on a device for creating a vacuum or neutral environment during the process of heating and processing ingots. The advantages of the method are cited as the creation of vacuums directly in the zones of heating, forming, and cooling; the feasibility of providing a high vacuum due to the small volumes of the vacuum space; and the rapid assembly and disassembly of the forging device. Tests were conducted on molybdenum heated in a hydrogen environment and formed in air, and on niobium heated in an argon environment and formed in air. The results were compared with those obtained from heating and forming these metals in a vacuum. The findings on vacuum forging indicate: (1) There is no saturation; microhardness along a cross section remains constant; fissuring does not occur; and pliability is increased. (2) Lubricants may be applied which eliminate gas vaporization during heating. (3) A vacuum creates effective conditions for plating and joining metals. M.G.J.

N67-40315*# Martin Co., Orlando, Fla.
STUDY ON DEVELOPMENT OF TECHNIQUES FOR RESISTANCE WELDING, PHASES I AND II Final Report, 20 Jun. 1966–28 Feb. 1967
D. A. Snedeker 28 Feb. 1967 71 p refs
(Contract NAS8-20339)
(NASA-CR-89649; OR-8741) CFSTI: $3.00 CSCL 13H

As a basis for providing a reliable in-process, instantaneous, automatic, nondestructive inspection technique, efforts were directed toward establishing the relationships between the infrared radiation (IR) emitted during the weld pulse cycle with the relative tensile strength of the weld. Variables such as weld pulse rise times and welder pressure settings were introduced. Statistical experiments were designed to vary the welding parameters, and individual IR measurements and weld tensile strength were recorded. The information was statistically analyzed and correlated with visual characteristics. The results confirmed the IR concept by correlating closely with optimum welding parameters derived from conventional isostrength diagrams. In conjunction with this technique, a go, no-go visual indicator was designed and breadboarded. Details are also given on a pseudoweld, or low energy weld, technique for in-process nondestructive preweld inspection. The method was found capable of predicting weld quality by the detection of undesirable preweld conditions. M.G.J.

N67-40367*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
NICKEL PLATING OF THE 23-FT COLLIMATING MIRROR FOR THE JPL 25-FT SPACE SIMULATOR
M. R. Heilig 1 Nov. 1967 16 p refs
(Contract NAS7-100)
(NASA-CR-89755; JPL-TR-32-1167) CFSTI: HC $3.00/MF $0.65 CSCL 13H

The successful nickel plating of the 23-ft-diam aluminum collimating mirror for the JPL 25-ft space simulator is described. JPL specifications for the work included the following: (1) good optical polishing properties that would provide a surface with which the grind and polish vendor was familiar and also provide a hardness of 50 Rockwell C (Rc); (2) a sufficient adhesion to withstand the optical polishing process; (3) a suitable surface reasonably free of pits, blisters, and blemishes; (4) continuous nickel plating to at least a thickness of 0.008 in. minimum, and (5) minimum handling of the mirror. The work was accomplished in three phases, which included the selection of grade II plating, experimentation with a 4-ft-diam mirror and plating of the 23-ft-diam mirror, itself. The third phase consisted of 11 operations, including pretreatment and final plating processes. The types of etching and rinsing solutions are described. Repairing pits and blemishes in the surface are also described. The use of a Magnagage and Dermitron to measure surface thicknesses is discussed, along with variances in thicknesses and problems encountered along the mirror edge. Author

N67-40400# Automation Industries, Inc., Boulder, Colo. Research Lab.
ADVANCEMENT OF ULTRASONIC TECHNIQUES USING RERADIATED SOUND ENERGIES FOR NONDESTRUCTIVE EVALUATION OF WELDMENTS Final Report
B. T. Cross and W. M. Tooley 30 Aug. 1967 62 p refs
(Contract NObs-92530)
(TR-67-53; AD-659033)

No single testing method presently exists that will provide a complete nondestructive evaluation of structural welds. An ultrasonic inspection technique called the Delta Technique has been developed. This technique has many advantages over present weld inspection techniques. The Delta Technique is not sensitive to any preferential defect orientation and it can provide a permanent record of the test results. Delta inspections have been conducted successfully for both thick and thin butt welds and various configurations of tee welds. An inspection speed of 50 feet per hour was obtained in the laboratory. This was the maximum operating speed of the laboratory mechanical fixturing system and not the maximum operating speed of the Delta Technique. As a result of this program, we have defined the operating parameters necessary for inspecting butt welds with the Delta Technique. It is possible to assign operating parameters for a butt weld of given thickness in a specific material. Manual and automatic Delta weld inspection techniques have been studied. Each are applicable to inspection of the hull welds used in submarine fabrication. The Delta Technique can provide the Navy with a means for rapid, economical evaluation of butt welds and, potentially, other weld configurations, such as the tee weld. Author (TAB)

N67-40414*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
DATA MANAGEMENT STUDY, VOLUME 5. APPENDIX C: CONTRACTOR DATA PACKAGE MANUFACTURING (MG) Final Report

T. F. Smyth 28 Jul. 1967 108 p Prepared for JPL
(Contracts NAS7-100; JPL-951112)
(NASA-CR-89707; VOY-CO-FR, Vol. 5, Append. C) CFSTI: $3.00
CSCL 13H

Data required to produce a finished product from a set of drawings and specifications are presented in the contractor data package for manufacturing of the Voyager spacecraft system. These data relate to planning, design, tooling and processes, scheduling, ordering, testing, fabricating, production control, and assembly as well as reporting procedures. Included are the data item list/user matrix, user flow diagrams, data requirement descriptions, a documentation relationship tree, and data item phasing/frequency.
M.W.R.

N67-40416*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
DATA MANAGEMENT STUDY, VOLUME 5. APPENDIX E: CONTRACTOR DATA PACKAGE QUALITY ASSURANCE (QA) Final Report
T. F. Smyth and J. R. Gottshall 28 Jul. 1967 26 p Prepared for JPL
(Contracts NAS7-100; JPL-951112)
(NASA-CR-89709; VOY-CO-FR, Vol. 5, Append. E) CFSTI: $3.00
CSCL 13H

Manufacturing verification tests to obtain quality assurance as well as control and review procedures that insure component, subsystem, and system design; manufacturing; assembly; and testing to meet the established specifications are presented in this contractor data package for the Voyager spacecraft. The quality assurance data user flow diagrams were developed to indicate the quality activities and required data items on Voyager to meet customer requirements. Also included are the overall data item list/user matrix, data requirement descriptions, documentation relationship trees, and data item phasing/frequency related to quality assurance management.
M.W.R.

N67-40418*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
DATA MANAGEMENT STUDY, VOLUME 5. APPENDIX G: CONTRACTOR DATA PACKAGE RELIABILITY ASSURANCE (RA) Final Report
J. B. Silverwood and K. R. Thomas 28 Jul. 1967 86 p Prepared for JPL
(Contracts NAS7-100; JPL-951112)
(NASA-CR-89711; VOY-CO-FR, Vol. 5, Append. G) CFSTI: $3.00
CSCL 14D

Data, plans, procedures, reports, and related information to insure system, subsystem, and component reliability of the Voyager spacecraft are detailed in this contractor data package that also covers reliability assessment and statistical sampling documentation. The data item matrix is presented along with data requirement descriptions, user flow diagrams, documentation relationship trees, and frequency and phasing charts specifically related to Voyager reliability assurance.
M.W.R.

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

N67-39396# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
LASERS IN SPACE, ON THE EARTH, AND UNDER WATER
V. N. Chernyshev 26 Apr. 1967 92 p refs Transl. into ENGLISH of the publ. "Lazery V Kosmose, Na Zemle I Pod Vodoy" Moscow, Voyennoye Izd. Min. Oborony SSSR, 1964 p 1–104
(FTD-MT-65-373; TT-67-62867; AD-658382)

The working principles are considered of quantum-mechanical generators and amplifiers of optical range-lasers. Laser devices of different types and assignments are discussed. Laser radiation (abroad they are sometimes called death rays) can be used not only as a weapon of destruction, but also as a means of super-range communication, detection, and navigation. The pamphlet generalizes extensive but separated material published in domestic and foreign periodic press. The work is designed for readers with secondary education, familiar with the bases of radio engineering.
Author (TAB)

N67-39408# Avco Corp., Wilmington, Mass. Space Systems Div.
LASER INDUCED SURFACE EFFECTS Final Technical Report
R. Schlier 10 Jul. 1967 40 p ref
(Contract DA-19-020-AMC-00521(X))
(AVSSD-0244-67-RR; AD-657600)

The document presents the results of experiments in which a moderate energy electron beam was used to probe the plasma created by a laser beam impinging on a graphite target.
Author (TAB)

N67-39452# Ballistic Research Labs., Aberdeen Proving Ground, Md.
OPTICAL METHOD FOR ANALYSIS OF ATMOSPHERIC EFFECTS ON LASER BEAMS
Paul H. Deitz Jul. 1967 46 p refs Presented at the Symp. on Mod. Optics, Sponsored by the Brooklyn Polytech. Inst., New York, 21–24 Mar. 1967
(BRL-MR-1840; AD-657559)

The report describes the design of an instrumentation system for the study of the effects of atmospheric turbulence on a collimated laser beam under near-earth conditions. The instrumentation consists of a helium-neon laser with optical collimator and a receiving system of 24-inch aperture with narrow bandpass filter. The Appendix presents examples of beam cross section patterns for different propagation conditions. The method of analyzing spatial intensity distributions of these patterns is described.
Author (TAB)

N67-39460# Rochester Univ., N. Y. Dept. of Physics and Astronomy.
STATISTICAL PROPERTIES OF ELECTROMAGNETIC RADIATION Final Report, 1 Aug. 1964–31 Jul. 1967
Emil Wolf Aug. 1967 28 p refs
(Grant DA-ARO(D)-31-124-G-569)
(AROD-4965-28-P; AD-657586)

The research carried out was chiefly concerned with the following topics: Behavior of the electromagnetic field in the focal region of a coherent beam, coherence effects of second and higher orders, correlation techniques in classical and quantum optics, theory of photoelectric detection of light fluctuations, phase space distributions of fluctuating electromagnetic fields, fluctuations in laser beams, Thomson scattering in intense laser beams, and correlation effects in many : .om radiation processes. Author (TAB)

N67-39604# Martin Co., Orlando, Fla. Electromagnetics Lab.
COHERENT LIGHT TRANSMITTER Final Technical Report, Dec. 14, 1965–May 1, 1967
V. E. Derr Wright-Patterson AFB, Ohio, AF Avionics Lab., Sep. 1967 70 p refs
(Contract AF 33(615)-2022)
(AFAL-TR-67-213; AD-658858)

The nuclear-pumped laser could, in theory, provide a small, efficient source of coherent optical radiation capable of many years of untended operation. The main deterrent to its realization is existence of the laser cutoff effect: quenching of laser action by high energy radiation. An hypothesis based on electron-induced superradiance is in agreement with the experiment. A low threshold laser material, YAG:Cr-Nd, has been found to resist this effect up to doses of 960 rads. Author (TAB)

N67-39615# Cornell Univ., Ithaca, N. Y. Materials Science Center.

A STUDY OF PHOTON LOSS IN THE ACTIVE AND PASSIVE REGIONS OF A SEMICONDUCTOR LASER Interim Technical Report

Robert G. Hunsperger Jun. 1967 134 p refs

(Contract DA-31-124-ARO(D)-364)

(Rept.-675; AROD-5560-3-E; AD-658676)

Measurement and evaluation was made of the photon loss in the active and passive regions of a GaAs laser pumped by an electron beam. A theoretical expression was developed which gives the threshold current density required to produce lasing in an electron-beam-pumped laser when a portion of the length between Fabry-Perot surfaces was masked from the electron beam. This theoretical relation was experimentally verified by measurement of threshold current density as a function of masked length for numerous samples of GaAs at 4K. On the basis of these measurements the photon loss coefficients in the active and passive regions of the laser crystals were determined. The loss coefficients were found to be strongly dependent on impurity doping concentration. In addition the loss coefficient in the active region was observed to be less than the loss coefficient in passive material. This is attributed to an inhibiting of interband absorptive transitions by the inverted population in the active region. Author (TAB)

N67-39737# Hughes Research Labs., Malibu, Calif.

SELECTIVE ACCESS LASER DISPLAY BEAM POSITIONER Final Report, 1 Mar. 1966–30 Apr. 1967

James F. Lotspeich, James E. Kiefer, Wilbur P. Brown, Jr., and Neal H. Cosand Griffiss AFB, N. Y., RADC, Aug. 1967 118 p refs

(Contract AF 30(602)-4097)

(RADC-TR-67-381; AD-658840)

The experimental investigations and analytical studies indicate that controlled refractive deflection of laser beams by iterated electro-optic prism arrays of KD^*P operated near the Curie temperature offers a promising approach to advancing the state of the art in high speed, selective access display applications. TAB

N67-39785*# Cutler-Hammer, Inc., Deer Park, N. Y. Airborne Instruments Lab.

HIGH-SENSITIVITY INFRARED RECEIVER DEVELOPMENT Quarterly Report, 1 Jul.–30 Sep. 1966

F. Arams, F. Pace, B. Peyton, and E. Sard 30 Sep. 1966 37 p refs

(Contract NAS5-10156)

(NASA-CR-89602; AIL-0323-1-2; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 20E

The program discussed developed a 10.6-micron infrared heterodyne mixer and associated IF preamplifier combining as high a sensitivity and as large an IF bandwidth as possible. Expressions for the conversion gain, noise equivalent power, and quantum noise factor of the photomixer in terms of the measured I–V characteristics were derived. Using measured I–V characteristics of a high-speed Ge:Cu mixer element with laser local-oscillator and quantum noise factor under various IF preamplifier conditions have been calculated. Calculations were made of the mixer carrier lifetime from the detector response. It is estimated that the high-speed Ge:Cu mixer with 7 milliwatt of laser LO power has low-noise capabilities due to a combination of optimum semiconductor lifetime, transit time, dynamic resistance, and circuit RC product. Author

N67-39892*# Massachusetts Inst. of Tech., Cambridge.

SPECTROSCOPIC APPLICATIONS OF OPTICAL AND INFRARED MASERS Semiannual Status Report, Nov. 1, 1966–May 31, 1967

P. Schroeder et al 29 Sep. 1967 37 p refs

(Grant NGR-22-009-240; Proj. DSR-70382)

(NASA-CR-89632; SASR-1) CFSTI: HC $3.00/MF $0.65 CSCL 20E

The technique for high resolution laser magnetospectroscopy has been developed using an amplitude stabilized infrared laser with He–Ne and He–Xe gas mixtures. The oscillatory interband magnetoreflection spectra have been obtained for single crystals of graphite, bismuth and arsenic, and pyrolitic graphite crystals. The Q-switching of CO_2 gas laser leads to a sudden decrease of population of the 001 level. Because of collisional coupling, the population of other nearby levels also change resulting in transient inversion of population at new transitions. The 4.3μ oscillation arising from this mechanism is now identified as 102→101. The ΔB for this transition is found to be $\pm 0.0031 \pm 0001$ cm^{-1}. The preliminary results of detailed study of very high gain stimulated transitions in the $N_2(0, 0)$ band $C^3\Pi_u \rightarrow B^3\Pi_g$ are presented in this report. The narrow frequency bandwidth of these lines which is characteristic of the high gain is discussed. Finally, a brief description of the discharge requirements and inversion mechanism concludes the present experimental situation. Author

N67-39919# Texas Univ., Austin. Labs. for Electronics and Related Science Research.

ANALYSIS AND EVALUATION OF SIMPLE ELECTROMAGNETIC MODELS FOR LASERS IN AXIAL MAGNETIC FIELDS AND PLANE DIFFRACTION GRATINGS

Marion O. Hagler and Arwin A. Dougal 15 Aug. 1967 144 p refs

(Grant AF-AFOSR-766-67)

(AFOSR-67-1766; TR-35; AD-658018)

By using a vector Kirchoff integral and introducing suitable approximations for the electromagnetic fields on the surface of a plane diffraction grating, the fraction of the diffracted radiation appearing in each diffraction order is calculated here. The results are given as an explicit closed form function of the shape of the grooves on the grating surface and the wavelength of the incident radiation. On the basis of the analysis, it is shown that for a grating with triangular grooves which are wide and shallow compared to a wavelength of the incident radiation, the maximum amount of radiation is directed into a given diffraction order when the groove shape is such that the radiation is specularly reflected from one face. Finally, comparison with experimental data confirms the accuracy of the calculations in parameter ranges for which the simple model of the grating is expected to be valid. A simple electromagnetic model of a laser immersed in an axial magnetic field permits the polarization state of the emitted radiation to be described as a function of the single pass Faraday rotation angle and the anisotropy coefficient of the Brewster windows. It is shown that as the single pass Faraday rotation angle of the lasing medium is increased toward some critical value determined by the resonator anisotropies, the laser output fields are linearly polarized and the frequency remains constant. The output polarization angle increases to a maximum value psi sub o determined by the resonator anisotropies. Author (TAB)

N67-40055# Johns Hopkins Univ., Baltimore, Md. Lab. of Astrophysics and Physical Meteorology.
ON THE PROPER USE OF LASER RADIATION IN THE CALIBRATION OF SPECTROMETER SCANNING FUNCTIONS Technical Report, 1 Jan. 1964–1 Nov. 1966
Louis Sica, Jr. 1 Jun. 1967 112 p refs
(Contracts Nonr-4010(14); AF 19(628)-4971; Grant CWB-10899)
(AD-654214)

Dependence of spectrometer scanning functions on the spatial coherence at the entrance slit implies that the spatial coherence of laser radiation must be degraded before its narrow spectral bandwidth can be used in scanning function calibration. Theoretical conditions on the necessary correlation function for "incoherent source" simulation are derived. Measurement of the correlation function at a slit in the case of an Hg source by the method of Beran and Parrent gives results which are in agreement with Hopkins' concept of an "effective source." Results using a laser-integrating sphere source indicate that it may be used interchangeably with an ordinary "incoherent" source for scanning function calibration. The problem of calculating the scanning function at any wavelength is discussed, and a common path interferometer which could be used to obtain the required output wavefront of a complete spectrometer is briefly described. It is shown that in the case of an Ebert spectrometer with a rectangular grating, some variation of the scanning function along the length of the circular slits is to be expected even in the case of perfect optics. Qualitative results of the use of a wave shearing interferometer in the measurement of the far field mutual intensity of a partially coherently illuminated slit are described. Author (TAB)

N67-40308# TRG, Inc., Melville, N. Y.
MULTI-MODE HIGH ENERGY LASER TRANSMITTER Interim Report, 6 Sep. 1966–15 May 1967
A. L. Pogoda and J. N. McGuire Aug. 1967 95 p
(Contract AF 33(615)-3888)
(IR-086-1; AD-658175)

The report outlines the progress made toward completion of the Multi-Mode High Energy Laser Transmitter System (MMHELTS) in the period from 6 September 1966 through 15 May 1967. In addition, it discusses design changes required for enhancement of the operation of the equipment in the field. Areas which TRG believe to be necessary additions and/or logical improvements to the operational capability of the overall system are discussed in detail. The overall configuration of the high energy system has not been changed from that in the design exhibit, submitted to Wright-Patterson Air Force Base on 1 September 1966. The ruby length of the Q-switched system, however, has been reduced to a total of 17 inches. The overall length has been divided into one Brewsters angled 4 in. Q-switched oscillator followed by 13 in. of active amplifier. The 13 in. amplifier section consists of a 4 in. cavity followed by a 9 in. cavity both of which are Brewsters angled. All ruby rods will remain 15mm in diameter. The status of the dynamic boresighting system development effort is also discussed herein. Author (TAB)

N67-40539# Minnesota Univ., Minneapolis. Dept. of Electrical Engineering.
THE EFFECT OF 3.39 MICRON SUPERRADIANCE ON THE 0.6328 MICRON OUTPUT POWER OF A HELIUM–NEON LASER
J. S. Hancock and J. A. Carruthers Aug. 1967 35 p refs
(Contract DA-31-124-ARO(D)-402; ARPA Order 676)
(TR-1; AD-659005)

The effect of competition in a 0.6328 micron helium-neon laser from the high-gain 3.39 micron line has been studied. The 50 milliwatt laser used for the investigation employs a six-foot Brewster-angle tube and has a prism at one end to insure that oscillation occurs only at 0.6328 microns. Measurements were made of the 3.39 micron superradiance from one end of the tube when various calibrated reflectors were placed at the other end. With a typical dielectric coated mirror, designed for maximum reflectivity at 0.6328 microns, the superradiant 3.39 micron power from the other end of the tube was 75 microwatts. This result shows that in a 6 foot visible laser filled with a 10:1, He(3)-Ne mixture and employing a single prism for frequency selection, the 3.39 micron superradiance does not significantly affect the visible output power. However, the superradiance is about 2 orders of magnitude larger than estimated from theory, and presumably results mainly from multiple reflections from the tube walls. Author (TAB)

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

N67-39389*# Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.
DEVELOPMENT AND EVALUATION OF MAGNETIC AND ELECTRICAL MATERIALS CAPABLE OF OPERATING IN THE 800°F TO 1600°F TEMPERATURE RANGE Quarterly Report, 1 Jun.–31 Aug. 1966
P. E. Kueser Sep. 1966 127 p refs
(Contract NAS3-6465)
(NASA-CR-54360; Rept.-66.63E) CFSTI: HC $3.00/MF $0.65
CSCL 11F

In the program for the solid rotors of electrical generators, the precipitation strengthened materials resulted in alloys having high yield and tensile strengths. Dispersion strengthening on cobalt-iron and cobalt-base alloys resulted in compositions with good creep resistance and saturation magnetization at 1400°F. The precipitation hardening provided strength below 1300°F and dispersion strenthening above that temperature. Four Nivco alloy specimens are still on creep test with the longest time approaching 9000 hours with the vacuum now at 1×10^{-9} torr. The high temperature capacitor program was completed with a satisfactory endurance test of 1000 hours. The change in the capacitor losses is the apparent result of a slight separation of the electrodes. Developments are also reported on alkali-metal compatible ceramic-to-metal seals and combinations of materials. The 5000-hour endurance tests were completed on the stator, transformer, and solenoid at 1100°F hot spot temperature. The electrical conductor and electrical insulation systems and all components showed no signs of deterioration. Author

N67-39485# Naval Research Lab., Washington, D. C.
THROUGH-THICKNESS NOTCH DUCTILITY AND TENSION PROPERTIES AS A FUNCTION OF NEUTRON EXPOSURE TO A SIMULATED PRESSURE VESSEL WALL OF A302-B STEEL
Charles Z. Serpan, Jr. and J. Russell Hawthorne 30 Jun. 1967 18 p refs
(NRL-6575; AD-658019)

Notch ductility and tension-property measurements have been made using specimens irradiated within a large steel test assembly simulating the pressure-vessel wall of a light-water-moderated power reactor. The A302-B steel specimens, spaced at intervals through the 6-in. thickness of the assembly, showed the greatest embrittlement and tensile property changes from irradiation locations nearest the fuel core, and correspondingly smaller changes farther from the core. Measured neutron fluxes of energies greater than 1 MeV, based upon an assumed fission

spectrum, compared well with calculated spectrum neutron fluxes of energies greater than 1 MeV for all test assembly locations, thus providing the basis for future estimates of property changes through the thickness of heavy-walled reactor pressure vessels. Author (TAB)

N67-39501# Martin Co., Baltimore, Md. RIAS Div.
ADSORPTION-INDUCED BRITTLE FRACTURE IN LIQUID METAL ENVIRONMENTS Annual Report
Albert R. C. Westwood, Carolyn M. Preece, and Madhusudan H. Kamdar May 1967 100 p refs
(Contract DA-18-001-AMC-1109(X))
(AR-1; AD-658210)

Solid metals can be caused to behave in a brittle manner by exposure to a variety of physical or chemical environments. Perhaps the most dramatic examples of such effects, however, result from exposure to surface active liquid metals. Specimens pre-stressed above some critical value fail virtually instantly on being wetted by an appropriate liquid metal, and brittle crack propagation rates of order 100 cm per sec. have been recorded in otherwise ductile metals under such environmental conditions. Such effects are presently considered to result from adsorption-induced reductions in the cohesive strength of atomic bonds at regions of stress concentration in the solid metal, e.g. at the tips of cracks or in the vicinity of piled up groups of dislocations. This paper describes the results of a number of recent investigations on this type of liquid-metal embrittlement, and discusses the prerequisites and possible mechanisms for its occurrence. Also discussed are the effects of such variables as chemical composition of the solid and liquid metal phases, temperature, prestrain, rate of loading, etc., on severity of embrittlement, and such topics as the possible correlation between severity of embrittlement and electronegativity, the use of inert carrier liquid metals, possible means of inhibiting liquid-metal embrittlement, and criteria for brittle failure. Author (TAB)

N67-39525# Army Weapons Command, Rock Island, Ill. Research and Engineering Div.
IMPROVED INSTRUMENTAL METHODS FOR RAPID ANALYSIS OF STAINLESS AND MARAGING STEELS Final Report
W. Dennis McHenry and Oren J. Littig Jun. 1967 26 p refs
(RIA-67-1593; AD-658074)

Six random samples of maraging steel were analyzed for manganese, chromium, molybdenum, nickel, copper, titanium, aluminum and cobalt for use as secondary standards for instrumental analysis. Analyses were made for these elements in solution by both optical and X-ray emission techniques as well as by the usual wet chemical methods. The range of the elements in the six samples was adequate except for nickel. By the use of these standards and others previously available, a direct reading optical emission spectrometer was calibrated for both maraging and stainless steels. Author (TAB)

N67-39544# Naval Research Lab., Washington, D. C.
THE CORROSION BEHAVIOR OF STAINLESS STEELS IN SEA WATER
M. H. Peterson and T. J. Lennox, Jr. Jun. 1967 32 p refs
(NRL-MEMO-1795; AD-657938)

The corrosion behavior of several series of stainless steels is discussed. Photographs of typical attack in both experimental panels and operational equipment are shown. Because of the susceptibility of stainless steel to pitting, its use in sea water should be avoided in new designs. The 300 series, however, may be used if provided with cathodic protection. The 400 series stainless steels are unsuitable for use in sea water even if provided with cathodic protection. Author (TAB)

N67-39571# New York Univ., N. Y. School of Engineering and Science.
STUDY OF THE EFFECT OF LIQUID ENVIRONMENT ON THE EMBRITTLEMENT OF SOLIDS Final Report, 1 Jan. 1959–31 Dec. 1966
I. B. Cadoff Jun. 1967 63 p refs
(Contract Nonr-285(43))
(AD-657854)

The effect of environment on the mechanical properties of solids was investigated. The two principal systems studied were: The embrittlement of copper and copper alloys in mercury and mercury amalgams. The embrittlement of silver chloride in aqueous solutions. The principal factors studied were alloy composition; microstructure, including grain size, precipitation effects, grain boundary orientation relationships; and composition of the liquid environment. In general it was found that embrittlement could be attributed to adsorption of active ions at sites of high stress concentration in the solid, with this adsorption resulting in lower cohesion between solid-solid bonds. High stress concentrations are associated with the dislocation interactions at high angle grain boundaries, precipitates and notches. Author (TAB)

N67-39593*# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
DEVELOPMENT OF DISPERSION STRENGTHENED TANTALUM BASE ALLOY Quarterly Progress Report, 20 May–20 Aug. 1966
R. W. Buckman, Jr. and R. C. Goodspeed 20 Aug. 1966 20 p refs
(Contract NAS3-2542)
(NASA-CR-72094; WANL-PR(Q)-012; QPR-11) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Development of dispersion strengthened tantalum base alloys for use in advanced space power systems continued with the composition selection and melting of scale-up compositions. The creep behavior was affected by final annealing temperature with time to 1% strain at 2400°F and 15,000 psi increasing from 262 to 494 hours as the 1 hour pretest annealing temperature was increased from 3000°F to 3630°F. The time to 1% strain for TIG welds tested in the as-welded condition at 2400°F and 15,000 psi was 171 hours. Author

N67-39595*# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
DEVELOPMENT OF DISPERSION STRENGTHENED TANTALUM BASE ALLOY Quarterly Progress Report, 20 Feb.–20 May 1966
R. W. Buckman, Jr. and R. C. Goodspeed 20 May 1966 70 p refs
(Contract NAS3-2542)
(NASA-CR-72093; WANL-PR(Q)-011; QPR-10) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Development of dispersion strengthened tantalum base alloys for use in advanced space power systems continued with the evaluation of oxygen contaminated and welded compositions which had been aged 1000 hours at 1800°F. The six alloys evaluated included carbide, nitride, and carbonitride strengthened types as well as two solid solution alloys. The effect of final annealing temperature on the creep behavior and room temperature mechanical properties of Ta–8W–1Re–0.7Hf–0.025C (ASTAR-811C) was investigated. The compositions of the remaining two four-inch diameter scale-up ingots were tentatively selected. Author

N67-39624# General Electric Co., Philadelphia, Pa. Missile and Space Div.
INVESTIGATION OF BONDING IN OXIDE-FIBER (WHISKER) REINFORCED METALS

W. Edwin Sauer, Willard H. Sutton, and Earl Feingold Watertown, Mass., Army Mater. Res. Agency, 15 May 1967 40 p refs
(Contract DA-19-066-AMC-330(X))
(AMRA-CR-66-01/4; AD-655583)

The work was part of a continuing effort to determine the effects which various additives have on the wetting and bonding of nickel and nickel alloys to single crystal sapphire. The effects of dilute alloys (0.002 to 0.088 atomic percent (a/o) Cr, Ti, and Zr were studied by sessile drop experiments, and the specimens characterized by electron microscopy and by electron probe microanalysis. A number of parameters which influence the wetting and the bonding were identified. In addition, some studies were made of the wetting of sapphire by 1 a/o alloys of Ce/Ni, Y/Ni, V/Ni. TAB

N67-39630# National Engineering Lab., Glasgow (Scotland).
A SIMPLE CRITERION OF FRACTURE FOR DUCTILE METALS
M. G. Cockcroft and D. J. Latham Jul. 1966 39 p refs
(NEL-240)

The subject of the macroscopic ductility of materials has been examined and it is proposed that a true ductility can be defined. A criterion of fracture has been developed which enables the fracture point under complex conditions to be predicted from a knowledge of the true ductility of a material. The criterion emphasises the importance of tensile stresses in controlling the onset of cracking and implies that compressive stresses have no effect on fracture. Its use has so far been restricted to problems of deformation at ambient temperature and it is not intended to be applied in situations where dominant metallurgical effects dictate the onset of fracture, but it has successfully been used in correlating room-temperature mechanical test data and in predicting the onset of cracking in metal working. Author

N67-39653*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
APPLICATION OF A METHOD OF ESTIMATING HIGH TEMPERATURE LOW CYCLE FATIGUE BEHAVIOR OF MATERIALS
G. R. Halford and S. S. Manson Washington, NASA, 1967 26 p refs Presented at the Natl. Metal Congr. Sponsored by the Am. Soc. for Metals, Cleveland, 19 Oct. 1967
(NASA-TM-X-52357) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Further study is made of a recently proposed method whereby tensile and stress-rupture properties may be used to estimate low-cycle, strain fatigue behavior in the creep range. The method is based primarily on the equation of universal slopes previously developed for predicting room-temperature fatigue and stress-rupture. Fatigue life estimates are presented and compared with a large quantity of fatigue data for nickel-base alloys, high- and low-alloy steels, stainless steels, and aluminum-base alloys tested under laboratory conditions over a wide range of temperatures and cycling frequencies. Author

N67-39667*# Case Inst. of Tech., Cleveland, Ohio.
EFFECT OF Ti, Zr, AND C ON STRUCTURE AND PROPERTIES OF A Co-35-W-3Cr-0.1B ALLOY, PART II
S. F. Ramseyer and J. F. Wallace [1966] 34 p refs
(Grant NsG-639)
(NASA-CR-89650) CFSTI: HC $3.00/MF $0.65 CSCL 11F

An investment cast alloy of base composition Co-35W-3Cr-0.1B was used to study the interactions of Ti, Zr, and C in determining structure and stress rupture properties at 1050°F in air. The atomic ratio of Ti plus Zr to C affected both the type and morphology of the second phases that formed. As the ratio increased from 0 to approximately 1/2, a continuous network of M_6C carbides with increased MC carbides occurred; above 1/2 to 1 the M_6C network was broken up, the particles becoming rounder and more equiaxed, and an increasing percent of MC carbides formed; and above 1, MC carbides and a new phase were observed. The atomic ratio of Ti and Z to C also affected stress rupture properties considerably. Optimum results were obtained with a ratio of .76. Two alloys based on this ratio, Co-35W-3Cr-0.1B with additions of 1Ti-1Zr-0.5C and 2Ti-2Zr-1C had stress rupture lives which compare very favorably with commercial Co-base alloys. Author

N67-39660* National Aeronautics and Space Administration, Washington, D. C.
CROSS SECTION OF THE PHASE DIAGRAM OF THE SYSTEM Al–Cu–Cd–Mn WITH A CONSTANT MANGANESE CONCENTRATION AT 500°C [RAZREZ DIAGRAMMY SOSTOYANIYA SISTEMY Al–Cu–Cd–Mn PRI POSTOYANNOM SODERZHANII MARGANTSA PRI TEMPERATURE 500°C]
O. S. Bochvar, K. S. Pokhodayev, and V. G. Badayev Washington, NASA, Oct. 1967 5 p refs Transl. into ENGLISH from Strukt. i Svoystva Aviats. Staley i Splavov (Moscow), 1966 p 123–127
(NASA-TT-F-11014) CSCL 11F

The phase composition and structure of the alloys in the aluminum corner of the system Al–Cu–Cd–Mn with a constant manganese concentration of 0.7% at 500°C are studied. A cross section of an isothermal model of phase diagram of this system is plotted from the results of two methods of investigation; metallographic analysis and measurement of the electrical conductivity of the alloys. Author

N67-39698# Martin Co., Orlando, Fla.
FORMATION OF STACKING FAULTS IN POLYCRYSTALLINE BRASS DURING TENSILE DEFORMATION
Henry M. Otte and R. P. I. Adler Jan. 1967 47 p refs
(Contract Nonr-3706(00))
(OR-8744; TR-17; AD-658098)

An X-ray diffraction study of a polycrystalline Cu-30 Zn tensile test piece shows the equilibrium stacking fault energy to be between 8.4 and 12.5 ergs/cm2, in fairly close agreement with previously published results based on transmission electron microscopy techniques. Author (TAB)

N67-39730# Army Materials and Mechanics Research Center, Watertown, Mass.
INFLUENCE OF TEMPERING, PRESTRAINING, AND RETEMPERING ON THE STRENGTH AND TOUGHNESS OF HIGH-STRENGTH 4340 STEEL
Eugene DiCesare Aug. 1967 22 p refs
(AMMRC-TR-67-02; AD-659003)

The influence of tempering, prestraining, and retempering on the strength and toughness of martensitic and bainitic 4340 steel rods was investigated. The initial heat treatment consisted of a quench and temper to obtain martensite in one group and formation of bainite at 575 F followed by tempering in the second group. Reductions of area of 4 to 5 percent were effected by cold drawing through a die with and without backpull, followed by a retempering treatment. Ultimate tensile strengths approaching 385,000 psi for the martensitic structure and 283,000 psi for the bainitic structure resulted with yield-tensile strength ratios approaching unity. Notch tensile strength of the bainite was superior to that of martensite at comparable strength levels. The prestraining also caused a yield point drop and/or serrations in the flow curves. This was influenced by specimen test temperature and strain rate, tempering temperature, and retempering temperature. Author (TAB)

N67-39760# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE EFFECT OF INTERMEDIATE CONDITIONING IN THE PROCESS OF STEEL FATIGUE ON STEEL DURABILITY

L. A. Glikman and V. P. Tekht 28 Feb. 1967 12 p refs Transl. into ENGLISH from Fiz. Metal. i Metalloved. Akad. Nauk SSSR, Ural Filial (Sverdlorsk), v. 22, no. 1, 1966 p 78–81

(FTD-HT-67-138; TT-67-62948; AD-658879)

Specimens of carbon steel 40 (0.37-0.45% carbon) and chromium stainless steel 2Kh13 (0.16-0.23% carbon, 12-14% chromium) were subjected to cyclic stresses 10-15% higher than their fatigue strength (29.5-30.6 and 33.7 kg/mm2, respectively) for a number of cycles equal to 75 to 95% of the number of cycles at failure. After that, the stress was lowered to 75-90% of the fatigue strength for 5,000,000 cycles (training period) and then returned to the initial magnitude, which was maintained up to failure. The training significantly improved the fatigue life of both steels. For instance, while untrained specimens of steel 40 under stresses 10 or 15% higher than fatigue strength failed after 192,650-353,500 or 230,650-239,950 cycles, respectively, the trained specimens failed after 254,200-750,600 or 259,400-352,200 cycles; 2Kh13 steel exhibited similar behavior. Post-training annealing of 2Kh13 steel at 650C for 2 hr in argon produced no additional beneficial effect. Author (TAB)

N67-39780*# Hughes Research Labs., Malibu, Calif.

SURFACE IONIZATION STUDIES ON REFRACTORY METALS AND METAL ALLOYS

O. K. Husmann Dec. 1966 143 p refs

(Contract NAS3-6270)

(NASA-CR-54675; HRL-6270S) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The use of high work function refractory metals and metal alloys for improvement of the ionization efficiency is of particular importance in connection with long term contact ion engine operation. Critical temperatures for cesium surface ionization and thermionic work functions on polycrystalline solid iridium, rhenium, and four tungsten–rhenium alloys were investigated. The critical temperatures are expressed by the equation $T_c = A/(B-\log j)$, with T in degrees Kelvin and j in amperes per square centimeter. The equation constants A and B, the work functions, and Richardson constants A' (all at zero E-field) are given. The minimum work functions for the cesiated tungsten-25 rhenium, rhenium, and iridium filaments are 1.3 eV, 1.1 eV and 1.3 eV, respectively. Author

N67-39786# Aerospace Corp., El Segundo, Calif. Electronics Research Lab.

EFFECT OF FREEZING RATE CHANGES ON THE MEAN COMPOSITION OF BINARY COMPOSITES

W. R. Wilcox Jun. 1967 7 p refs

(Contract AF 04(695)-1001)

(TR-1001(2250-10)-11; SSD-TR-67-129; AD-657765)

Exact analytical expressions have been found for the compositional changes caused by a sudden change in the freezing rate of an off-eutectic melt. These show that the previous numerical results of Mollard and Flemings are slightly in error for a short distance following the freezing rate change. Author (TAB)

N67-39862*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

CERTAIN GENERAL PATTERNS IN THE OCCURRENCE OF HYDROGEN BRITTLENESS IN THE ALLOYS VT3-1 AND VT15

B. A. Kolachev, V. A. Livanov, N. Ya. Gusel'nikov, and A. A. Bukhanova Redstone Arsenal, Ala., Redstone Sci. Inform. Center, 26 Jul. 1967 22 p refs Transl. into ENGLISH from Novye Issled. Titanovykh Splavov (USSR), 1965 p 212–220 Prepared jointly with Army Missile Command

(NASA-TM-X-60551; RSIC-613) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Discussed is the development of hydrogen brittleness in an $(\alpha+\beta)$-titanium alloy VT3-1 and a β-titanium alloy VT15. It is shown that hydrogen brittleness develops most intensely in VT3-1 at temperatures less than room temperature and at low strain rates. It is discovered that β-titanium alloys at temperatures below room temperature are also prone to hydrogen brittleness, the temperature at which this occurs decreasing with a decrease in the hydrogen content. Hydrogen brittleness in the alloy VT15 is found to occur only at low strain rates in a narrow temperature range, approximately from $-30°C$ to $+10°C$. Hydrogen brittleness of $(\alpha+\beta)$-titanium alloys is believed to be caused by processes developing in the β-phase during plastic deformation. Since the composition of the β-phase of VT3-1 after isothermal annealing is close to the composition of the β-phase of VT15, it is concluded that hydrogen brittleness develops in approximately the same manner in both of them, provided the conditions for mechanical testing are the same for both. Author

N67-39894# Naval Research Lab., Washington, D. C.

STRESS-CORROSION CRACKING CHARACTERISTICS OF ALLOYS OF TITANIUM IN SALT WATER

R. W. Judy, Jr. and R. J. Goode 21 Jul. 1967 53 p refs

(ARPA Order 878)

(NRL-6564; AD-658721)

The salt water stress-corrosion cracking (SCC) characteristics have been determined for a large number of titanium alloys representatives of commercial production. These data were compiled as part of an NRL program directed to determining the underlying principles of SCC in metals and to establishing procedures for improving the SCC resistance of these metals as well as learning to tolerate the problem where it exists. The SCC resistance was determined using a precracked cantilever bend specimen with analysis by fracture mechanics techniques. The test results for the spectrum of alloys and weldments studied indicate that no correlation with mechanical properties exists, which makes precise prediction of SCC properties of particular alloys difficult, if not impossible. The data obtained provide guideline information for programs similar in nature to the NRL program as well as for alloy development, design and materials selection, and specifications and quality control. Author (TAB)

N67-39909# Atomics International, Canoga Park, Calif.

HEAVY WATER ORGANIC COOLED REACTOR. THE EFFECT OF SOME FABRICATION VARIABLES ON THE MECHANICAL PROPERTIES OF SINTERED ALUMINUM POWDER (SAP) SHAPES

W. J. Anderson and P. B. Ferry 15 Aug. 1967 44 p refs Prepared jointly with Combust. Eng., Inc.

(Contract AT(38-1)-430)

(AI-CE-36) CFSTI: HC $3.00/MF $0.65

Short-time tensile tests of rod, and tensile and tube-burst tests of tubing specimens of SAP alloys were conducted to provide preliminary information concerning the effects of thermal-mechanical history on mechanical properties. Comparison of effects of final fabrication indicated that mechanical properties of SAP are improved, to a point, during hot compressive working, and then might decrease when a critical degree of working is exceeded. Tube-burst test results indicated that the presence of longitudinal fins on SAP fuel cladding tube neither increases nor decreases its inherent strength in a short-term test. The difference in deformation, and the fracture location in tube-burst tests of cladding tube with fins removed, indicates a difference in mechanical behavior of the tube wall under fins and the tube wall between fins. The difference in behavior is attributed to differences in the mechanical working of the areas. Author (NSA)

N67-39915 Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile & Space Systems Div.

GRAIN REFINEMENT IN 2014/4043 ALUMINUM ALLOY

W. A. Bailey and W. V. Mixon 23 Nov. 1966 27 p refs
(DAC-59536)

In an attempt to alter the herring-bone microstructure often found in MIG welds, various grain refining techniques were investigated in 2014/4043 aluminum alloy. Using cast, end-chilled plates, it was demonstrated that grain size can be reduced in a cast blend of these alloys by an increase in solidification rate induced by either chilling or by a reduction in pouring temperature and by the addition of grain refiners of various effectiveness. Chromium addition did not affect grain size. The most effective innoculant was a combination of titanium, boron and beryllium. This combination has proved an effective grain refiner in the originally cast plate, in a bead-on-plate TIG weld made along the plate surface, and in an actual MIG butt weld made with 2014-T6 sheet and an experimental 4043 wire containing purposeful additions of these elements. Author

N67-39922# Technische Hochschule in Wien (Austria). Institut für Angewandte Physik.
PREPARATION OF THE INTERMETALLIC COMPOUND YCo_5 BY THE AMALGAM PROCESS
Franz Lihl 3 Nov. 1966 38 p refs
(Contract AF 61(052)-942)
(SR-1; AD-658218)

The intermetallic compound YCo5 promises to be an excellent material for high quality permanent magnets. It is, however, essential to prepare this compound in single domain particles of a grain size of the order of 10 micromillimeters. The preparation of YCo5-powders by means of the amalgam process is described in detail. The process consists of several steps, namely: (1) Preparation of Y-amalgam by solving yttrium-metal at 450C in liquid mercury; (2) preparation of Co-amalgam by electrolysis; (3) mixing of the amalgams; (4) distillation of the mercury at temperatures up to 1100C. By X-ray investigations the structure of YCo5 was confirmed and the range of homogeneity established to be very small. Metallographic and magnetic measurements proved that the amalgam process actually is a preferable means for preparing YCo5 powders. Author (TAB)

N67-39940 Joint Publications Research Service, Washington, D. C.
NIOBIUM-BASED ALLOYS AND THEIR PROPERTIES
Ye. M. Savitskiy, V. V. Baron, and K. N. Ivanova 30 Oct. 1967 13 p refs Transl. into ENGLISH from Atomnaya Energ. (Moscow), v. 23, no. 7, Jul. 1967 p 32-37
(JPRS-43171; TT-67-33796) CFSTI: $3.00

Several refractory niobium based alloys were developed and their properties investigated. The alloys are characterized by good technological applications and can be fabricated into sheets, bars, tubing, and wire. Alloys containing tungsten, molybdenum, and zirconium (PH-6 and PH-5) are among the most heat resistant grade PH alloys exhibiting substantial short term and long term strength. The alloys can be subjected to dispersion hardening. The PH-6 alloy obtained by centrifugal casting has better mechanical properties than do alloys obtained by arc and electron beam methods, because of its fine grain structure. Alloying of niobium alloys with titanium instead of zirconium results in a lower strength rise, especially at high temperatures; however, their plasticity is somewhat increased. Type PH alloys have high corrosion resistance in lithium at 1000°C and also in solution of hydrochloric and sulfuric acids. R.N.A.

N67-39997# Army Materials Research Agency, Watertown, Mass.
PROPERTIES OF SEVERAL STRUCTURAL U-Mo-Cb-V-Ti ALLOYS
Stanley W. Wolf and F. J. Rizzitano Jun. 1967 24 p refs
(AMRA-TR-67-18; AD-658679)

Metallurgical properties of twelve alpha-gamma uranium alloys based on the composition U-Mo-Cb-V-Ti (alloying elements varied from 1/8 to 4-1/2 weight percent), including the corrosion resistance of three of these alloys, were determined for various heat treatments and related to the metallographic structure after heat treatment. In general, tensile ductility and impact energy were increased at constant tensile strength levels for material extruded, solutionized, and isothermally transformed rather than extruded and aged. Grain size was considerably enlarged and chemical homogeneity improved by the solutionized heat treatment. The properties of these alloys were compared with the U-2Mo-2Cb-2Zr-1/2Ti alloy developed previously. Substituting vanadium for zirconium raised the ductility and lowered the strength of these alloys. Corrosion resistance in boiling water at atmospheric pressure was improved by replacing zirconium with vanadium. Author (TAB)

N67-40040*# City Coll. Research Foundation, New York.
FUNDAMENTALS OF THE OXIDATION PROTECTION OF COLUMBIUM AND TANTALUM Semiannual Report, Apr. 1-Oct. 1, 1967
M. Kolodney and R. A. Graff 1 Oct. 1967 35 p refs
(Contract NGR-33-013-017)
(NASA-CR-89635; SAR-4) CFSTI: $3.00 CSCL 11F

Fundamental processes involved in the oxidation protection of tantalum and niobium by their silicides are reported. Results are included for thermochemical data for the silicides, glass structure and growth, oxidation rates and coating modifiers, and substrate-coating interaction barriers. The silicides, with additives as required, were used in bulk form; and disks were fabricated by cold pressing and sintering to obtain specimens of over 90% theoretical density. M.W.R.

N67-40084*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A STEREOGRAPHIC REPRESENTATION OF KNOOP HARDNESS ANISOTROPY
M. Garfinkle and R. G. Garlick Washington: NASA, Nov. 1967 14 p refs
(NASA-TN-D-4226) CFSTI: HC $3.00/MF $0.65 CSCL 11F

During the course of an investigation of the hardness anisotropy of several body-centered-cubic (BCC) metal crystals, it became evident that the variation of Knoop hardness with crystallographic orientation was dependent essentially on the direction of the long axis of the indentor alone, and not on the plane of indentation. The study was extended to include a face-centered-cubic (FCC) and a close-packed-hexagonal (CPH) metal and an ionic crystal to determine the generalities of this observation. For cubic crystals, this observation was valid; for the CPH structure, however, the planes of identification did have some effect on the hardness anisotropy, although this was not nearly as significant as the direction of indentation. Because the direction of indentation is the only significant crystallographic parameter necessary to describe the hardness anisotropy, it is possible to represent the anisotropy of single crystals on the standard stereographic triangle. Author

N67-40088*# Farnham (Frank C.) Co., Philadelphia, Pa.
ON THE ROLE OF HYDROGEN IN THE PROCESS OF STEEL FAILURE IN NEUTRAL CORROSIVE MEDIA. [K VOPROSU O ROLI VODORODA V PROTSESSE RAZRUSHENIYA STALI V NEYTRAL'NYKH KORROZIONNYKH SREDAKH]
V. I. Tkachev and R. I. Kripyakevich Washington, NASA, Oct. 1967 8 p refs Transl. into ENGLISH from Fiz.-Khim. Mekhan. Materialov (Moscow), v. 1, no. 6, 1965 p 688-693
(Contract NASw-1497)
(NASA-TT-F-11280) CFSTI: $3.00 CSCL 11F

Low-cycle plastic fatigue (alternating deformation above the yield point) was studied on 08 KP steel to determine low

degrees of hydrogen absorption taking place in neutral electrolytes. The specimens were subjected to bend tests beyond the elastic limits (plastic fatigue). A platinum spiral served as the anode during polarization. From the test results, polarization curves, i.e., graphs of plastic fatigue versus density of the cathodic polarization current were plotted. The curves obtained for the action of neutral and acid electrolytes in the presence of cathodic polarization were qualitatively similar, which constitutes an indirect confirmation of the hydrogen embrittlement of the metal in neutral electrolytes in the presence of plastic fatigue. The decrease in plastic fatigue under the influence of hydrogen at relatively low cathodic current densities is reinforced by the presence of stress concentrators produced by selective corrosion. Author

N67-40111 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
RELAXATION PHENOMENA IN METALS AND ALLOYS [RELAKSATSIONNYYE YAVLENIYA V METALLAKH I SPLAVAKH]
10 May 1967 39 p refs Transl. into ENGLISH from Tr. III, Vsesoyuznoy Nauchn. Konf. (Moscow), 1963 p 214–220, 290–293, 326–331
(FTD-MT-65-262; TT-67-62868; AD-658371)

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3. INVESTIGATION OF REGULARITIES OF STRESS RELAXATION G. F. Lepin and L. M. Toptunova p 13–19 refs (See N67-40114 24-17)

N67-40112 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EFFECT OF THERMOMAGNETIC TREATMENT ON INTERNAL FRICTION OF PERMINVAR AND 66-PERMALLOY [VLIYANIYE TERMOMAGNITNOY OBRABOTKINA VNUTRENNEYE TRENIYE PERMINVARA I 66-PERMALLOYA]
F. N. Dunayev, N. S. Malev, and N. B. Borisova *In its* Relaxation Phenomena in Metals and Alloys 10 May 1967 p 1–12 refs (See N67-40111 24-17)

Investigated are changes, introduced by thermomagnetic treatment, in the dependence of the internal friction of Perminvar and 66-Permalloy on temperature and magnetic field. The internal friction and shear modulus were measured with the help of a torsional pendulum. All samples were annealed at 100° for 2 hours, and heated to 650°, holding for 1 hour, and subsequent fast (100 deg/min) or slow (100 deg/hr) cooling. Thermomagnetic treatment was done under both conditions of cooling: 66-Permalloy was cooled in magnetic field of 1 and 3 oersteds from 650°, and Perminvar—in a field of 50 oersted from 770°. Thermomagnetic treatment greatly increased the internal friction of 66-Permalloy at temperatures of 0–400°; the greater the magnetic field applied during cooling, the greater the increase of internal friction. Analogous results are obtained for samples of Perminvar. After thermomagnetic treatment, the period of oscillation increases as the internal friction, but the dependence of it on the field does not become monotonic. Author

N67-40113 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
RELAXATION STABILITY OF CERTAIN IRON–NICKEL ALLOYS [RELAKSATSIONNAYA STOYKOST' NEKOTORYKH ZHELEZONIKELEVYKH SPLAVOV]
S. I. Doroshek and A. M. Tseytlin *In its* Relaxation Phenomena in Metals and Alloys 10 May 1967 p 21–30 refs (See N67-40111 24-17)

This work presents certain results of a study of stress relaxation in N41KhT and N36KhTYuM alloys after work hardening and tempering. The required combination of physical and elastic properties is attained through age-hardening of hardened and tempered, hardened cold-formed and tempered material. The material used (chemical composition given) was a flattened strip produced from wire with a high (80%) total reduction while drawing, with hardening from 1050°C before drawing. The strips were tempered in salt melts at 300–800°C for 1 hr, after which the following mechanical properties were measured: hardness, tensile strength, elastic limit when bending, springiness angle, Curie point and saturization magnetization. Relaxation tests were conducted at different temperatures for different periods, but at a definite initial stress. The removed stress, relaxation stress, and the relative values of these characteristics in percents were calculated. Author

N67-40114 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF REGULARITIES OF STRESS RELAXATION [ISSLEDOVANIYE ZAKONOMERNOSTY RELAKSATSII NAPRYAZHENIY]
G. F. Lepin and L. M. Toptunova *In its* Relaxation Phenomena in Metals and Alloys 10 May 1967 p 13–19 refs (See N67-40111 24-17)

Experimental and calculated relaxation curves of 30KhMA steel are given and the developed loading diagram, used during the repair of five steam turbines, produced joints that did not steam during one and a half years of operation. Author

N67-40143# Aktiebolaget Atomenergi, Stockholm (Sweden).
IRRADIATION EFFECTS AT 160–240°C IN SOME SWEDISH PRESSURE VESSEL STEELS
M. Grounes, H. P. Myers, and N-E. Hannerz Sep. 1967 37 p refs
(AE-298) CFSTI: $3.00

Tensile specimens, Charpy impact specimens, and miniature impact specimens of six steels in different conditions were irradiated to 2.8×10^{18} and 5.6×10^{18} n/cm^2 (>1 MeV) at 160–240°C. The steels investigated were SIS 142103, 2103/R3, NO 345, Fortiweld, Fortiweld HS, and OK 54 P. There is no correlation between the increase in transition temperature and initial transition temperature. However, changes in strength and ductility can be correlated to the initial yield strength. The increases in transition temperature due to strain aging and irradiation are approximately additive. The irradiation-induced changes in 2103/R3 and Fortiweld HS steels do not vary with position in the thickness of the plate. Different tempering treatments in Fortiweld HS steel do not change the extent of irradiation effects. Normal Charpy V-notch impact specimens and miniature specimens give the same irradiation-induced increase in transition temperature. Author

N67-40171# General Electric Co., Philadelphia, Pa. Missile and Space Div.
THE HYPERSONIC, DIFFUSION-CONTROLLED OXIDATION OF TUNGSTEN
Leon M. Gilbert Jul. 1967 68 p refs
(R67SD38)

In this study, a theoretical analysis is presented for the high temperature, diffusion-controlled, oxidation of tungsten in a dissociated air stream. A five component gas model is formulated, consisting of the four dominant species of dissociated air (i.e., O, O_2, N, N_2) and the combustion product W_3O_8. The effects of multicomponent concentration diffusion and multicomponent thermal diffusion are rigorously treated and the Dufour term is included in

the energy flux vector. Locally-similar numerical solutions to the resulting set of boundary layer equations are presented. The theoretical heat and mass transfer rates obtained for tungsten are compared with those characterizing the ablation performance of graphite. Good agreement is obtained when these theoretical predictions for tungsten oxidation are compared with experimental data. Various approximate theories are discussed and compared with the results obtained by the more rigorous methods described. Author

N67-40215 Aerospace Industries Association of America, Inc., Washington, D. C. Materials and Structures Committee.
EVALUATION OF ALUMINUM ALLOY 7001-T75
August Cicinella Dec. 1966 114 p
(TR-101) Available from National Standards Assoc., Inc., Washington, D. C.: $7.50

The purpose of this work was to establish design criteria for a material with the strength of 7075-T6 and virtual immunity to sress and exfoliation corrosions. The alloy 7001-T75 was evaluated in the form of sheet, plate, extruded, hand forged, and die forged. The results of tensile tests for each 7001-T75 product form show the strength to be above the required minimums of applicable standards for 7075-T6 but in general below the typical or "B" values. In modifying artificial aging cycles to improve resistance to stress and exfoliation corrosions, strength and corrosion resistance are a trade-off. Thermal cycles that provide the greatest corrosion resistance result in the lowest strength and vice versa. One tensile test in the transverse grain direction was below the minimum for 7075-T6, the averages of all other tests were above. Alternate immersion corrosion tests showed that 7001-T75 is resistant to stress corrosion cracking and that it will pass a 30-day test. Loaded specimen sizes must be selected to prevent mechanical failure due to cross section reduction resulting from pitting corrosion. 7001-T75 is resistant to exfoliation corrosion but is not immune to intergranular attack. Fracture toughness characteristics of 7001-T75 were found to be intermediate to those for 7075-T6 and 7178-T6. K.W.

N67-40235*# Case Inst. of Tech., Cleveland, Ohio.
DEPENDENCE OF STRESS RUPTURE AND SUPERPLASTICITY ON STRUCTURE IN Co-W ALLOYS, PART I
C. Vishnevsky and J. F. Wallace [1967] 108 p refs
(Grant NsG-639)
(NASA-CR-89651) CFSTI: HC$3.00/MF$0.65 CSCL 11F

Stress rupture tests of four Co-W base alloys were conducted at 1800 and 1850°F in air using as-cast specimens produced in conventional investment molds and unidirectionally solidified. These alloys were also extruded to investigate the properties of hot worked structures. Variable strain rate tests of extruded Co-45-0.05Zr at 1800°F were employed in a study of superplasticity. In as-cast alloys, changes in rupture life and ductility on undirectional solidification were determined by the favorable longitudinal alignment of grain boundaries competing with the geometry, orientation, and distribution of second phases. The existence of superplasticity in extruded Co-45W-0.05Zr was established, and continued recrystallization or grain boundary migration during deformation is suggested by microstructural evidence. Author

N67-40352# Los Alamos Scientific Lab., N. Mex.
HIGH-TEMPERATURE ENVIRONMENTAL TESTING OF LIQUID PLUTONIUM FUELS
R. L. Andelin, L. D. Kirkbride, and R. H. Perkins 17 Jul. 1967 24 p refs
(Contract W-7405-ENG-36)
(LA-3631) CFSTI: HC$3.00/MF$0.65

Equipment for testing containers for liquid Pu alloys at 900° to 1100°C was developed and used. Uncarburized and carburized Ta and Ta–5W capsules were tested with Pu, Pu–Fe, and Pu–Co–Ce. The Pu–Co–Ce alloys were less corrosive than Pu–Fe (10 at.% Fe), which in turn was less corrosive than Pu. Carburization of Ta and Ta–5W containers greatly improved their corrosion resistance to liquid Pu alloys. Carburized Nb–10W and Nb–1Zr alloys were satisfactory containers for Pu–Co–Ce alloys containing 2 g Pu/cm^3. Author (NSA)

N67-40360# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
THE COMPATIBILITY OF W-26% Re WITH THORIA AND THORIA-PLUTONIA
A. T. Jeffs Sep. 1967 8 p refs
(AECL-2768) CFSTI: HC$3.00/MF$0.65

The results are reported of laboratory and irradiation tests to determine the compatibility of tungsten–rhenium thermocouple alloy with thoria and thoria-plutonia under the conditions of a proposed instrumented pellet rod. The tests proved satisfactory. The absence of any evidence of interaction gives confidence in the behavior of the complete thermocouple under operating conditions. Author

N67-40375 Mitsubishi Heavy-Industries, Ltd., Nagasaki (Japan).
A STUDY OF FATIGUE STRENGTH IN WELD METAL AND H.A.Z. OF MILD STEEL WELD
Masaki Watanabe, Kin-ichi Nagai, Ako Otsuka, and Yoshiya Nagata Aug. 1967 11 p refs
(MTB-010051)

In order to find the reasons for poor fatigue strength of welded part of a mild steel, fatigue tests were performed by using small specimens with semi-circular and V notches located respectively at the base metal, the weld metal, and the heat affected zone in welded joint. Results showed that the weld metal and the heat affected zone, especially the spheroidized pearlite zone, were more notch sensitive than the base metal. The relationship between fatigue strength and crack propagation rate on the respective zones of welded joint is discussed. Author

N67-40389 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
FURNACE FOR THE PREPARATION OF THE HIGH MELTING POINT METAL SINGLE CRYSTALS [PIEC DO OTRZYMYWANIA MONOKRYSZTALOW METALI TRUDN TOPLIWYCH]
1967 12 p refs In POLISH; ENGLISH summary
(INP-797/II)

A resistance furnace for the preparation of the high melting point metal single crystals with a wire heating element fastened on one side is described. In the heating element there is no high temperature contact of the heating wires with ceramic, that guarantees its long lasting exploitation. The furnace can work with a vacuum or with an inert gas. Preparation of Fe 16 Cr alloy single crystals using this apparatus is described. Author

N67-40453 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
THE PROPERTIES OF PAR-1 ALLOY FOR THE CONSTRUCTION OF THE CORE OF NUCLEAR REACTOR EWA 10 MW [WLASNOSCI STOPU PAR-1 PRZEZNACZONEGO NA ELEMENTY KONSTRUKCYJNE RDZENIA REAKTORA EWA 10]
B. Bochenek and L. Saulc 1967 38 p refs In POLISH; ENGLISH summary
(INP-779/XIV/PS)

The results of analyses of the physical, mechanical, and nuclear properties of the wrought elements of PAR-1 alloy are

reported. Focused upon is the use of this alloy for the EWA 10 MW reactor core. The possibility of using this alloy in the construction of nuclear reactors was confirmed. Author

N67-40459# Eidgenössische Technische Hochschule, Zürich (Switzerland).
INFLUENCE OF COLD-WORKING ON THE HARDENING STATES OF AlMgSi ALLOYS [EINFLUSS DER KALTVERFORMUNG AUF DAS AUSHAERTUNGSVERHALTEN VON AlMgSi-LEGIERUNGEN]
Ferenc Szekeres (Ph.D. Thesis) 1967 138 p refs In GERMAN Supported in part by the Swiss Aluminum Res. Inst.
(DISS-3927) CFSTI: HC $3.00/MF $0.65

Investigated were the reciprocal effects between cold working and age hardening in aluminum-magnesium-silicon alloys. Initial cold working increased their hardness but subsequent room temperature aging weakened maximal hardness values by strengthening electrical resistance and thus inducing plastic dedormation. Cold worked specimens, undergoing secondary room temperature aging after initial aging showed even further increased electrical resistance. Alloys containing excessive amounts of magnesium and silicon possessed higher electrical resistance after room temperature hardening than quasi-binary alloy combinations. Annealing of quasi-binary aluminum-silicon-magnesium alloys was also accelerated by preceding primary cold working. Transl. by G.G.

N67-40501# Compagnie des Ateliers et Forges de la Loire, Paris (France). Centre de Recherches.
[TESTING OF STAINLESS STEELS] Quarterly Report, Oct.–Dec. 1966
Dec. 1966 124 p refs Transl. into ENGLISH from French
(Contract EURATOM-033-64-9-TEEF (RD))
(EURAEC-1865; EUR-3369; QR-9) CFSTI: HC $3.00/MF $0.65

The behavior of 8 kinds of stainless steel was tested in solutions of $MgCl_2$, NaCl, and $CaCl_2$ under mechanical stress. Tests were also conducted in superheated steam on stainless steel wires under tensile stress. A surface processing, that could considerably increase the resistance to corrosion of Cr plated under gas, is being developed. The stress-corrosion tests emphasized the importance of electrochemical factors and their modification according to the composition and the structure of the steel. General corrosion tests in water at 350°C were also carried out and the austenitic steels seemed to be superior to the austeno–ferritic steels. NSA

N67-40646# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
OXIDATION OF ZIRCONIUM–ALUMINUM ALLOYS
B. Cox Oct. 1967 25 p refs
(AECL-2776) CFSTI: HC $3.00/MF $0.65

Examination of the processes occurring during the oxidation of Zr–1% Al, Zr–3% Al, and Zr–1.5% Al–0.5% Mo alloys has shown that in steam rapid oxidation occurs predominantly around the Zr_3Al particles, which at low temperatures appear to be relatively unattacked. The unoxidized particles become incorporated in the oxide, and become fully oxidized as the film thickens. This rapid localized oxidation is preceded by a short period of uniform film growth, during which the oxide film thickness does not exceed ≈200 Å. Once the solubility limit of aluminum is exceeded, the size, distribution and number of intermetallic particles affects the oxidation rate merely by altering the distribution of regions of metal giving high oxidation rates. The oxidation rates in atmospheric pressure steam are very high and their irregular temperature dependence suggests that the oxidation rate will be pressure dependent. This was confirmed in part, by a comparison with oxidation in moist air. It was found that the rate of development of white oxide around intermetallic particles was considerably reduced by the decrease in the partial pressure of H_2O; the incubation period was not much different, however. Author

N67-40699# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
RATE CONTROLLING PROCESSES DURING THE OXIDATION OF ZIRCONIUM ALLOYS
B. Cox Oct. 1967 24 p refs
(AECL-2777) CFSTI: HC $3.00/MF $0.65

A study of the potentials developed across growing oxide films on zirconium alloys, and I-V curves produced by polarizing these specimens during oxidation, has shown that quantitative interpretation of the potentials in terms of a rate controlling process is not possible at present. Qualitative interpretations of the results have shown how the rate controlling process may be affected by the presence of alloying elements in the form of intermetallic particles, and by changes in the experimental conditions. Author

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

N67-39393*# General Precision, Inc., Little Falls, N. J. Aerospace Group.
HIGH TEMPERATURE STABLE CARBORANE ADHESIVES Final Report
Robert Barnes, et al 15 Jan. 1967 52 p refs
(Contract NAS9-5527)
(NASA-CR-65734) CFSTI: HC $3.00/MF $0.65 CSCL 11A

The terminal diolefins, bis(butenyl)carborane and bis(hexenyl)carborane, were prepared and converted to the corresponding diepoxide monomers, bis(epoxybutlyl)carborane and bis(epoxyhexyl)carborane. Polymerization was demonstrated with several different catalytic reagents. Both epoxy derivatives were easily cured to hard solids at 175°C in the presence of boron trifluoride monoethylamine. Evaluation of the cured systems for adhesive applications was initiated based on this catalyst. Lap-shear test specimens were assembled from type 17-7 stainless steel strips. Bond strength values increased markedly during the program as curing conditions were optimized and lay-up conditions were improved. Room temperature bond-strengths up to 2810 p.s.i. were achieved with the bis(epoxyhexyl)carborane system. The corresponding epoxybutyl system gave values up to 1840 p.s.i. Post cure at 250°C for one hour in the former resulted in a decrease of 15–25% in the room temperature bond strengths. Failure was cohesive in all instances where glass cloth was used as a binder in the joint area. The results are sufficiently encouraging to suggest that further work will lead to a practical high temperature adhesive system. Author

N67-39416# Textile Research Inst., Princeton, N. J.
STUDIES AND EXPERIMENTAL INVESTIGATIONS IN CONNECTION WITH CHEMICAL BONDING IN RESIN-TREATED CELLULOSE Final Report
Robert F. Schwenker, Jr., John J. Williard, and H. D. Weigmann 15 May 1967 103 p refs
(Contract DA-19-129-AMC-23(X))
(Rept.-68-15-PR; AD-658173)

The nature of the interactions between methylolmelamine resins and cotton was investigated. A new chemical analytical method for the elucidation of the chemical structure of resin-treated cotton was developed. Data are presented for the degree of substitution of cellulose by trimethylolmelamine, and for the distribution of these substituents between the various hydroxyl groups of the anhydroglucose unit under various curing conditions. It

was shown by an investigation of weathered resin-treated cotton samples that periodate oxidation can be used as a sensitive index of the structural changes occurring during resin degradation. Microscopy and solubility studies in the cellulose solvent cadoxen, in connection with Smith degradations, were found to provide a method for assessing any cellulose chemical treatment for uniformity and effectiveness of covalent cross-linking. Preliminary results are presented on the distribution of resin substituents along the cellulose chain, and considerable nonuniformity of resin substitution is indicated. Author (TAB)

N67-39422# Lowell Technological Inst. Research Foundation, Mass.

EFFECTS OF DYNEL FIBER BLENDING ON YARN SHRINKAGE AND WOVEN-FABRIC PROPERTIES Technical Report, Jan. 1966–Jan. 1967

Paul J. Angelo, Jr., David H. Pfister, John A. Goodwin, and Victor Duxbury Army Natick Labs., Mass., Clothing and Organic Mater. Div., Jan. 1967 71 p

(Contract DA-19-129-AMC-894(N))

(TR-67-64-CM; AD-658062)

Regular and high shrink Dynel were blended in varying proportions and patterns and spun into 16(s) yarns with two twists. Microscopic examination showed semblances of expected groupings, but the high shrink fibers tended to migrate to the outside. Shrinkages of the yarns in water (200F) were measured under varying tensions. Minor loading reduced shrinkages to low levels, suggesting that mechanics of shrinkage in free yarn are different than those in fabric. There was little correlation of the yarn shrinkage results with the different combinations. Maximum shrinkage occurred in the 50/50, low-twist, draw-frame yarn with alternate feed. The least shrinkage in blended yarns was in low-twist yarns with greater proportions of high-shrink fiber. A 50/50 picker blend warp was woven with fillings from the various blends and twists. The fabrics were scoured and treated for water repellency. Highest shrinkage in scouring occurred with low-twist fillings while final shrinkage showed the reverse. High-twist filling yarns produced less air permeability. Differences in shrinkage and air permeability among various blend arrangements were not significant. There was little correlation among the results of yarn and fabric shrinkage and air permeability. All water repellency tests were poor; fabrics with low-twist fillings were better than those of high twist. Overall, among blended yarns, the 50/50 pair arrangements with one drawing seemed more favorable and distinctly better than the 50/50 picker blend. Author (TAB)

N67-39442# Polytechnic Inst. of Brooklyn, N. Y.

RELAXATION PROPERTIES OF POLYESTER BASED POLYURETHANE UNDER SMALL DEFORMATIONS SUPERPOSED ON LARGE DEFORMATIONS

T. T. Wang and J. M. Klosner Jul. 1967 38 p refs

(Contract Nonr-839(32)(FBM))

(PIBAL-937; AD-658328)

An investigation was carried out to determine the extensional mechanical behavior of a viscoelastic material when it is subject to an infinitestimal displacement field superposed on a finite steady deformation. Experiments were conducted on a thin strip of a polyester based polyurethane at a temperature of about 77 F. It is shown that the relaxation modulus of this material can be expressed as a product of two functions, one of which depends only upon the elongation ratio and the other only upon time. This form is applicable for basic state elongation rations 1 < or = lambda < or = 1.2 and for a period of two hours. It is noted that the separable form is highly suspect for longer time intervals. Author (TAB)

N67-39497# Army Weapons Command, Rock Island, Ill. Research and Engineering Div.

EFFECT OF SEVERAL GAS ATMOSPHERES ON HYDRAULIC FLUID SHEAR STABILITY

Ralph L. Le Mar Aug. 1967 21 p refs

(RA-67-1954; AD-658057)

The sonic-shear stability of polyisobutylene and polymethacrylate solutions in oil was examined under several gases and at pressures up to five atmospheres. Tests were conducted in a pressurized sonic treatment cup under nitrogen, hydrogen and helium atmospheres. Comparison tests under air were made at one atmosphere. Results indicated that sonic-shear stability varied inversely with gas solubility for all the gases, except air at one atmosphere. Both polymer solutions displayed highest viscosity losses under the helium atmosphere. The use of gases other than air and sonic test cell pressurization showed promise as a modification of the sonic-shear method, to make it more closely reflect mechanical-shear tests. Author (TAB)

N67-39582# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

THE EFFECT OF IMPREGNATION AND CRYSTALLITE ORIENTATION ON THE RADIATION INDUCED CONTRACTION OF GRAPHITE

J. H. Cox, Jr. Jul. 1967 22 p refs

(Contract AT(45-1)-1830)

(BNWL-380) CFSTI: HC$3.00/MF$0.65

Effects of crystallite orientation and impregnant level on radio-induced bulk contraction in polycrystalline graphite were studied. Radiations reached a maximum exposure of 1.3×10^{21} nvt (E>0.18 MeV) in a temperature range of 500 to 700°C. The description of graphite as a single-phase description material effected a correlation between crystallite orientation and dimensional changes in a series of samples that were identical except for the degree of anisotropy. However, increasing the impregnant level increased the dimensional changes and showed that the single-phase description was inadequate as a completely general method of characterizing the radiation behavior of graphite. Author (NSA)

N67-39589# Naval Research Lab., Washington, D. C.

FULL-SCALE FIRE MODELING TEST STUDIES OF "LIGHT WATER" AND PROTEIN TYPE FOAMS

Henry B. Peterson, Edward J. Jablonski, Raymond R. Neill, Richard L. Gipe, and Richard L. Tuve 15 Aug. 1967 58 p refs

(NRL-6573; AD-658318)

A comprehensive study was made of the fire-control and extinguishing effectiveness of Light Water and protein type foams on full-scale fires of the type associated with aircraft accidents. An air aspirating nozzle and a specially designed nozzle using Refrigerant-12 as a blowing agent were interchanged and used to produce Light Water foams of different physical properties. Both the Light Water and protein foam liquid concentrates used were of the 6-percent type. The margin of superiority of Light Water over protein foam was found to be as high as 3 to 1 for control as determined by radiometer and visual measurements of avgas fires and as high as 1.5 to 1 for control of JP-5 fires. Complete fire extinguishment was achieved with application densities as low as 0.026 gal/sq ft of Light Water on JP-5 and 0.035 gal/sq ft on avgas, while protein required 0.043 gal/sq ft and 0.085 gal/sq ft respectively. The dual-agent fire-fighting concept, wherein equal quantities of Light Water and P-K-P dry chemical were discharged from a twin turret, showed no advantage over the use of Light Water foam alone in gaining control of the large-scale fires. The new 6-percent Light Water concentrate was effectively used in both the MB-5 vehicle foam-pump system and the air-aspirating type foam maker as well as with Refrigerant-12. TAB

N67-39621*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STATIC, SUBSONIC, AND SUPERSONIC OXIDATION OF JT GRAPHITE COMPOSITES
John D. Buckley Washington, NASA, Oct. 1967 41 p refs
(NASA-TN-D-4231) CFSTI: HC$3.00/MF$0.65 CSCL 11D

An experimental investigation was made to characterize and evaluate the high-temperature performance and self-generating protective oxide coating of three JT graphite composites. The effects of preoxidation on the tensile and compressive strength of JT graphite composite specimens tested at room temperature are shown. Static oxidation tests at temperatures up to 1760°K at 1 atmosphere (101 kN/m^2) and at 1925°K at 1×10^{-6} torr (0.1 mN/m^2) were performed to observe coating formation. Tests made in air, nitrogen, and air-nitrogen mixtures in subsonic and supersonic gas streams produced front-face surface temperatures up to 3000°K. A coating study was made with X-ray diffraction to identify the composition to the composites produced under various atmospheres, pressures, and temperatures. A possible mechanism for the coating formation is discussed. An oxide coating formed on the JTA graphite composite at elevated temperatures in oxidizing atmospheres provides good resistance to further oxidation under static, subsonic, and supersonic oxidizing conditions. Room-temperature tensile and compressive strength tests of preoxidized specimens showed a decrease in strength with increased temperature and/or time. Author

N67-39758# Astro Research Corp., Santa Barbara, Calif.
HIGH MODULUS, HIGH STRENGTH FILAMENTS AND COMPOSITES Technical Report, 1 Oct. 1964–15 Apr. 1966
Robert M. Witucki Wright-Patterson AFB, Ohio, AF Mater. Lab., May 1967 146 p refs
(Contract AF 33(615)-2177)
(ARC-R-213; AFML-TR-66-187; AD-658872)

The presence of internal stresses in boron filaments was inferred from experiments showing strain relief. In addition, measurements were made of the change in tungsten substrate length occurring during boron filament fabrication of the thermal expansion of boron filament to 1030C, and of the creep rate at 1070C. A model for filament formation is proposed in which the first significant step in filament fabrication is the formation of a continuous boron sheath around the tungsten substrate. Subsequent reaction between the boron sheath and the tungsten substrate results in the formation of tungsten borides at the interface having specific volumes much less than that of the reactants. Residual internal stresses present in boron filaments arise from three principal sources. These include core volume changes during filament fabrication, differential thermal contraction between the boron sheath and the core on cooling from filament formation temperature, and stresses in the boron sheath inherent in the vapor deposition process. Stresses were calculated for a selected filament from analysis, and values given for the filament surface, for the core interface, and for the core. TAB

N67-39793# Israel Inst. of Tech., Haifa. Material Mechanics Lab.
EXPERIMENTAL INVESTIGATIONS ON THE DYNAMIC STRENGTH OF COMPOSITES
S. R. Bodner and J. M. Lifshitz Jun. 1967 35 p refs
(Contract AF 61(052)-951)
(MML-6; SR-5; AFOSR-67-1983; AD-657820)

A number of experimental techniques for investigating various dynamic properties of composite materials are reviewed. In order to study filler-binder interaction during straining, especially the onset of unbonding, an apparatus was developed for the continuous measurement of the dynamic modulus and damping during constant rate of strain tests. The relation of changes in the dynamic modulus and damping to the development of failure mechanisms is discussed. Various methods of dynamic viscoelastic characterization and strength determination are reviewed. These include stress wave techniques for the investigation of the fracture strength at high loading rates. The various experiments were performed on samples of an unfilled and quartz particle filled epoxy resin. The results of these studies are also reported. Author (TAB)

N67-39830# Air Force Systems Command, Wright-Patterson AFB, Ohio. AF Materials Lab.
SILICON CARBIDE FILAMENT REINFORCED EPOXY RESIN COMPOSITES Technical Report, May–Aug. 1966
H. P. Materne and R. J. Kuhbander May 1967 21 p
(AFML-TR-66-383; AD-658443)

A series of composites were prepared with a nominal 4-mil diameter silicon carbide monofilament in an epoxy resin matrix. The average tensile strength of the silicon carbide filament was 360,000 psi and the average modulus of elasticity 61,000,000 psi. The filaments were prepared by the chemical vapor process using 0.5-mil diameter tungsten as a substrate. Filament characterization consisted of mechanical, physical, and morphological property evaluation. Composite fabrication was achieved by preparing preimpregnated and B-staged monolayer tapes for plying into unidirectional and balanced bidirectional composites. Composite evaluation consisted of tensile, flexure, shear and compressive strength, and moduli determinations. Unidirectional composites, containing 62 volume-percent filament, exhibited an average flexural strength of 260,000 psi and an average flexural modulus of 33,400,000 psi. These evaluations have permitted the preliminary assessment of the capability of silicon carbide as a potentially high performance reinforcing filament. Author (TAB)

N67-39952# IIT Research Inst., Chicago, Ill.
ANALYSIS OF MECHANICAL TESTING PROCEDURE FOR BRITTLE MATERIALS Interim Report, Mar. 1966–Mar. 1967
S. A. Bortz and T. B. Wade Watertown, Mass., Army Materials Res. Agency, Sep. 1967 204 p refs
(Contract DA-19-066-AMC-321(X))
(AMRA-CR-67-09/1; AD-658695)

The purpose of the research is to provide a guide for investigators in the performance of mechanical tests and the interpretation of test results. A review of the philosophy of testing and the problem areas in studying brittle materials is provided. Research effort consists of investigating mechanical test procedures and analyzing property data with regard to these test procedures, so that the best practice can be determined. Evaluated information is organized into three sections: (1) Test philosophy, test techniques and analytical methods. (2) Correlation of laboratory tests and recommended procedures. (3) Tabular presentation of test data. Author (TAB)

N67-40016# Monsanto Research Corp., St. Louis, Mo.
HIGH PERFORMANCE COMPOSITES Annual Project Review and Technical Report, 1 May 1966–30 Apr. 1967
John D. Calfee 12 Jul. 1967 258 p refs
(Contract N00014-67-C-0218; ARPA Order 873)
(HPC-67-28; AD-658533)

The finite-element method was used to calculate the longitudinal stiffness of short fiber composites; the instability of parallel edge cracks determined from the energy concept and the strength and inherent crack size obtained from the stability calculations; Youngs modulus calculated for randomly oriented fibrous composites; a mathematical approach proposed for calculating stress fields around interior cracks; and invariant properties of a laminated composite derived from the transformation equations of the anisotropic moduli. The electron scanning microscope provided insight into fracture mechanics; composites were improved by incorporating a flexible layer around the fiber; polyacrylic acid reacted with ZnO to produce a high modulus, temperature-resistant matrix;

data obtained indicating silane couplers decrease water diffusion at the interface; a decrease in fracture toughness associated with a change in crack propagation mechanism; and the viscosity of aggregate suspensions described by the Mooney equation. Techniques were developed for whisker fiber classification; strands of well-oriented whisker fibers made and fabricated into high performance composites; x-ray diffraction techniques applied to measuring fiber orientation, property maps developed for short fiber composites; short boron fibers encapsulated to make a pre-preg molding compound in bead form; fiber-matrix dry mix molding explored; and data obtained relating matrix properties to fatigue characteristics. TAB

N67-40072# Joint Publications Research Service, Washington, D. C.

PROPERTIES OF SOME CERAMIC AND INSULATING MATERIALS

18 Sep. 1967 49 p refs Transl. into ENGLISH from Russian (JPRS-42628; TT-67-33256) CFSTI: $3.00

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2. ELECTRICAL CONDUCTIVITY AND DIELECTRIC LOSSES IN POLYVINYL CHLORIDE PLASTICIZED RESIN V. M. Anikeyenko, K. M. Kevroleva, R. M. Kessenikh, and V. G. Sotnikov p 7–15 refs (See N67-40074 24-18)

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4. CHANGES IN THE MECHANICAL CHARACTERISTICS OF SOME SOLIDS FROM THE ACTION OF GAMMA-RAYS S. V. Starodubtsev, S. A. Azizov, I. A. Domoryad, Ye. V. Peshikov, and L. P. Khiznichenko p 30–42 refs (See N67-40076 24-26)

N67-40073 Joint Publications Research Service, Washington, D. C.

SOME PHYSICAL PROPERTIES OF ALUMINUM NITRIDE

T. V. Andreyeva, I. G. Barantseva, Ye. M. Dubnik, and V. L. Yunko *In its* Properties of Some Ceram. and Insulating Mater. 18 Sep. 1967 p 1–6 refs Transl. into ENGLISH from Teplofiz. Bysokikh Temperatur, Akad. Nauk SSSR (Moscow), v. 2, no. 5 p 829–831 (See N67-40072 24-18)

To determine the physico-technical properties of aluminum nitride, experiments were conducted on compact samples obtained by cold pressing of a powder of aluminum nitride in a binder, with subsequent sintering in a nitrogen medium at 2173°K. The chemical composition in nitrogen and aluminum was nearly stoichiometric. The samples contained up to 4% free carbon. Measurements were made of the temperature dependence of the volumetric specific resistance, the coefficient of heat conductivity, the coefficient of thermal expansion, the frequency dependences of the permittivity, and the angle of the dielectric losses. It was concluded that the physical properties determined for aluminum nitride indicate that this compound is a typical dielectric with a great width of the forbidden zone, and a high electrical resistance which reaches, for pure samples, 10^{20} ohms/cm. Calculation of the electron component of the thermal conductivity shows that the conductivity is brought about only by lattice vibrations. M.G.J.

N67-40074 Joint Publications Research Service, Washington, D. C.

ELECTRICAL CONDUCTIVITY AND DIELECTRIC LOSSES IN POLYVINYL CHLORIDE PLASTICIZED RESIN

V. M. Anikeyenko, K. M. Kevroleva, R. M. Kessenikh, and V. G. Sotnikov *In its* Properties of Some Ceram. and Insulating Mater. 18 Sep. 1967 p 7–15 refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Fiz. (Tomsk), no. 5, 1962 p 75–80 (See N67-40072 24-18)

Electric conductivity measurements were made on several plasticized resin formulas, and the temperature–frequency characteristics of the tangent of the angle of the dielectric losses and dielectric permeability are determined. The results indicate: (1) The polyvinyl chloride (PVC) plasticized resins have low electrical properties, which testifies to their great polarity. (2) In assessing the dependence of the current on time, it was established that the decrease of current with time for elevated temperatures is more delayed than at room temperatures. (3) The presence of plasticizers in PVC resins causes a displacement of the maximum of the tangent of the angle of the dipole–elastic losses towards lower temperatures of the glass transition. (4) The dielectric permeability at the maximum has absolute values reaching 9 to 10. (5) The absolute values of the specific volume resistance lie within the limits $2 \cdot 10^{12}$ to 1.10^{13} ohm/cm. M.G.J.

N67-40075 Joint Publications Research Service, Washington, D. C.

DIELECTRIC PERMEABILITY AND DIELECTRIC LOSSES IN SOME CERAMIC MATERIALS IN STRONG HIGH-FREQUENCY ELECTRIC FIELDS AT HIGH TEMPERATURES

I. S. Filatov *In its* Properties of Some Ceram. and Insulating Mater. 18 Sep. 1967 p 16–29 refs Transl. into ENGLISH from the book "Fizika Dielektrikov, Trudy Vtoroy Vsesoyuznoy Konferentsii" USSR, Acad. of Sci. USSR, 1958 p 28–36 (See N67-40072 24-18)

A nonstationary calorimetric method was used to measure ε and tan δ on samples of the ceramic compound, which included some variations of the crystalline, vitreous, and gaseous phases. The electrodes were applied to the sample by burning a silver paste. Before measuring, the samples were washed with benzene and dried at 180° to 200°C for eight hours. Results of the measurements are tabulated and depicted. These show: (1) In strong high frequency fields at high temperatures, dielectric losses in ceramic materials consist of relaxation and ionization losses and conductivity losses. Ionization losses dominate. (2) An increase in the quantity and dimensions of pores, the temperature, frequency, field voltage, and the duration of the applied voltage are conducive to developing ionization processes and lead to increases in ε and tan δ. (3) Changes in the vitreous and crystalline phases of the ceramic do not considerably change its ε and tan δ in strong fields at high temperatures. M.G.J.

N67-40147# United Kingdom Atomic Energy Authority, Harwell (England). Ceramics Div.

INTERACTION BETWEEN A CRACK FRONT AND CLEAVAGE STEPS

F. F. Lange and K. A. D. Lambe Jun. 1967 12 p refs (AERE-R-5498) CFSTI: HC$3.00/MF$0.65

Observations of the interaction of a crack front with cleavage steps in MgO are presented and show that: (1) steps exert a dragging force proportional to their height and, (2) the crack front forms a series of tongue-shaped segments that overlap one another at large steps; upon connecting with one another, they form steps with undercut surfaces. Based on these observations and on the hypothesis that a crack front possesses a line tension, a model is proposed to explain the overlapping of one part of a crack front with the other, resulting in the formation of cleavage whiskers and foils of material that are associated with cleavage fracture. The energy absorbed during the parting of the steps is discussed. Author

N67-40189*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
STRUCTURE AND KINETICS OF DEFECTS IN SILICON
Martin M. Sokoloski Washington, NASA, Nov. 1967 21 p refs
(NASA-TN-D-4154) CFSTI: HC$3.00/MF$0.65 CSCL 20K

This paper reviews defects in the diamond-type lattice with special emphasis on silicon, which is used as the basic material in the fabrication of solar cells in space programs. The defects are classified as first, second, and higher generation defects, according to their complexity. Some of these defects include vacancies and interstitials (as in lithium, for example) which are first generation defects capable of migrating above certain temperatures and trapping charge carriers. These first generation defects, because of their mobility, can form more complicated defects, such as the Si-A and Si-E centers. The properties of such defects have been systematically tabulated. A short discussion is given on some simple models of the kinetics of such defects. A comprehensive bibliography is given at the end of the review which should help the uninitiated commencing research in this field. Author

N67-40270*# Stanford Research Inst., Menlo Park, Calif.
POLYMERS FOR SPACECRAFT APPLICATIONS Final Report, Jun. 1964–Aug. 1967
R. F. Muraca and J. S. Whittick 15 Sep. 1967 256 p Prepared for JPL
(Contracts NAS7-100; JPL-950745; SRI Proj. ASD-5046)
(NASA-CR-89557) CFSTI: HC$3.00/MF$0.65 CSCL 11I

The spacecraft environment was considered to be a shielded thermal-vacuum environment of about 125°C and 10^{-6} torr. The theory of the release and condensation of substances from polymers exposed to the thermal-vacuum environment is discussed in detail, and the equipment and procedures for identifying and measuring the release of volatile condensable material (VCM) are described. The apparatus and techniques for evaluating the effect of pre-flight decontamination cycles and thermal-vacuum exposure on the mechanical and electrical properties of polymeric products are described, and the applicability of short-term tests (24–500 hours) in predicting long-term performance is reviewed. About 350 polymeric products were screened for outgassing characteristics, of which about 100 qualify within the limits of <1% wt-loss and <0.1% VCM content. About 20 products were examined in greater detail and found to be satisfactory for spacecraft construction. A thorough test and evaluation program to qualify polymeric products through any pre-flight or space environment is described. Author

N67-40297# European Atomic Energy Community, Ispra (Italy).
PROPERTIES AND USE OF ARALDITES EMPLOYED IN PHOTOELASTIC TECHNIQUES [PROPRIETES ET MISE EN OEUVRE DES ARALDITES UTILISEES EN PHOTOELASTICITE]
M. Veaux Aug. 1967 106 p refs In FRENCH; ENGLISH summary
(EUR-3604.f) CFSTI: $3.00

Findings on the use of epoxy resins, particularly Araldite, in photoelastic studies plus the bulk of the information available on the subject are presented. The mechanial and optical properties of the material are examined and compared with values determined in various laboratories. Consequently, the proper material suitable for each case is selected: two-dimensional study, stress-freezing technique, casting of large pieces. The two ways of fabrication, namely, casting and machining are considered. All details of the casting procedure are studied and the results concerning each grade of resin are summed up in the fabrication forms. The machining conditions for each type of machine-tool are also indicated. Author

N67-40337*# Case Inst. of Tech., Cleveland, Ohio.
[DIFFUSIVE MIXING AS A TOOL FOR CONFIRMING THE ORIGIN OF TEKTITES] Semiannual Report, Apr. 1, 1967–Sep. 30, 1967
Alfred R. Cooper [1967] 33 p ref
(Grant NGR-36-003-100)
(NASA-CR-89773) CFSTI: $3.00 CSCL 11B

Sample preparation, electron microprobe procedures, and results of measurements and interpretation of the homogeneity of Thailand tektites are described. Compositional variation for a variety of elements is shown in X-ray fluorescence photographs at appropriate wave lengths when the sample was scanned. Tables recapitulate quantitative results on tektite and synthetic glass homogeneity. Progress is also reported for self diffusion measurements of Si^{4+}, Sr^{2+}, and K^{+} in the system K_2O–SrO–SiO_2. E.C.

N67-40358# Princeton Univ., N. J. Frick Chemical Lab.
TENSILE STRENGTH OF RUBBERS
A. V. Tobolsky and P. F. Lyons Sep. 1967 13 p refs
(Contract Nonr-1858(07))
(ONR-TR-RLT-99; AD-659065)

A current theory of the tensile strength of rubbers invokes large scale crosslink interchange at room temperature to explain the high tensile strengths of networks crosslinked with weak linkages. This mechanical lability of certain crosslinks has been assumed from their known thermal lability at higher temperatures. Relaxation of stress experiments at various elongations were performed at room temperature on networks crosslinked with both weak and strong linkages. The purpose was to detect mechanically-induced crosslink slippage. No evidence was found of any mechanical lability of weak crosslinks at room temperature. A hypothesis is presented which explains the high tensile strengths of rubbers crosslinked with weak linkages as resulting from an internally relaxed network formed by the thermal lability of the crosslinks at the vulcanization temperature. This theory is shown to be consistent with some previously unexplained experimental results. Author (TAB)

N67-40485 Japan Atomic Energy Research Inst., Ibaraki. Div. of Power Reactor Development.
A SENSITIVE CAPILLARY PLASTOMETER FOR SLURRIES
Yasaburo Yamazaki, Matsuo Komori, and Toshihiro Oba 1967 34 p refs In JAPANESE; ENGLISH summary
(JAERI-1117)

A capillary plastometer has been designed incorporating certain features to make it especially suitable for use with slurries. The plastometer consists of a jacketed slurry tank with a double stirrer, a glass capillary with water jacket, a slurry receptacle for flow rate measurement, pressure regulating system and temperature control system. Six different capillaries which have inner diameters within the range of 0.151–0.368 cm were prepared. Different combinations of capillaries and the outlet pressures permit accurate measurement at the shear rate range of 100 to 10,000 per second. As a check on the accuracy of the plastometer, tests were made using distilled water and a 51.34% glycerol solution as the fluids being measured. The results were in good agreement with the standard values. The behavior of the plastometer were examined with calcium carbonate and titanium dioxide slurries. Results obtained with different diameter capillaries on the same slurry at the same range of shear rate agreed with each other. A liquid displacement technique on measuring flow rate of dense slurries has been developed to afford better accuracy. Author

N67-40550*# IIT Research Inst., Chicago, Ill.
INVESTIGATION OF THE INFLUENCE OF OZONE ON THE STABILITY OF DC-704 IN A DIFFUSION PUMP VACUUM SYSTEM Final Report, 1 Nov. 1966–1 Jun. 1967

Jerry Farrell 1 Jun. 1967 41 p
(Contract NAS5-10301)
(NASA-CR-89770) CFSTI: $3.00 CSCL 11H

The stability of new DC-704 fluid in a diffusion pump vacuum system was studied when ozone was leaked into the system at very low leak rates for eight hour periods. The influence of various rates of ozone leakage into a diffusion pump vacuum system containing DC-704 which had been used for as much as 143 days was studied during extended periods of ozone leakage into the system. The results of these studies tend to verify the conclusion reached previously that ozone, under the proper conditions, will generate an explosive reaction in a diffusion pump vacuum system using DC-704 fluid. These results also indicate the reaction generated in DC-704 fluid is not readily generated or duplicated in an operating diffusion pump. Author

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

N67-39397# Research Analysis Corp., McLean, Va. Advanced Research Dept.
SECOND-ORDER CONDITIONS FOR CONSTRAINED MINIMA
Garth P. McCormick Jun. 1967 23 p refs
(Contract DA-44-188-ARO-1)
(RAC-TP-260; AD-658069)

This paper establishes two sets of second-order conditions--one that is necessary, and the other that is sufficient that a vector chi* be a local minimum to the constrained optimization problem: minimize f(chi) subject to the constraints g sub i(chi) = or > 0, i = 1,...,m, and h sub j(chi) = 0, j=1,...,p where the problem functions are twice continuously differentiable. The necessary conditions extend the well-known results obtained with Lagrange multipliers that apply to equality-constrained optimization problems, and the Kuhn-Tucker conditions that apply to mixed inequality and equality problems when the problem functions are required only to have continuous first derivatives. The sufficient conditions extend similar conditions that have been developed only for equality-constrained problems. Examples of the applications of these sets of conditions are given. Author (TAB)

N67-39423# Wisconsin Univ., Madison. Mathematics Research Center.
APPROXIMATE SOLUTION OF INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS BY BOUNDARY VALUE TECHNIQUES
Donald Greenspan Jun. 1967 27 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-752; AD-657587)

Initial value problems are studied numerically by means of two distinctly different types of boundary value techniques. The problems treated are those for which either asymptotic estimates or results about the periodicity of solutions are available. Nontrivial examples which contain singularities and/or nonlinearities are discussed. Also, an example is provided for which initial value techniques diverge while boundary value techniques yield accurate approximations. Author (TAB)

N67-39435# Wisconsin Univ., Madison. Mathematics Research Center.
HIGHLY ACCURATE DISCRETE METHODS FOR NONLINEAR PROBLEMS
Victor L. Pereyra May 1967 120 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-749; AD-657576)

We study in this work the acceleration of the convergence of discretization algorithms for the solution of nonlinear operator equations in Banach spaces. Two methods, usually used with finite difference schemes, are extended to this general case and their asymptotic properties are established. These are: the Successive Extrapolations method (Richardsons extrapolation to the limit, Romberg integration), and the Iterated Deferred Corrections method (Foxs difference correction). The application of these procedures to nonlinear boundary value problems in one and two dimensions is discussed in detail and a complete set of numerical examples is presented. This includes the problem of finding periodic solutions in the case of forced oscillations. Author (TAB)

N67-39446# Harry Diamond Labs., Inc., Washington, D. C.
CONTINUOUS PIECEWISE-LINEAR CHEBYSHEV APPROXIMATION TO A HYPERBOLA
Paul G. Hershall Jun. 1967 17 p
(HDL-TM-67-11; AD-658003)

A simple method is presented that allows continuous piecewise-linear Chebyshev approximation to the hyperbola y = 1/x. A relative error criterion is used. The endpoints are assumed to be on the curve, and the n-1 intermediate points of the n-segment approximating function are found. Computer results for the case n = 10 are included. Author (TAB)

N67-39461# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
BLANCH ANNIVERSARY VOLUME
Bertram Mond, ed. 21 Feb. 1967 376 p refs
(AD-657323)

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8. RECURSION FORMULAS FOR POLYNOMIALS IN RATIONAL APPROXIMATIONS TO GENERALIZED HYPERGEOMETRIC FUNCTIONS Y. L. Luke (Midwest Res. Inst.) p 161-187 refs (See N67-39469 24-19)

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10. GENERALIZED TRAPEZOID FORMULAS AND ERRORS IN ROMBERG QUADRATURE R. E. Lynch (Tex. Univ.) p 215-229 refs (See N67-39471 24-19)

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14. THE MIGHTY MAN–COMPUTER TEAM I. Rhodes (Natl. Bureau of Standards) p 277–284 (See N67-39475 24-08)

15. PRODUCTS AND QUOTIENTS OF GENERALIZED CAUCHY VARIABLES R. P. Rider (Rose Polytech. Inst.) p 285–289 refs (See N67-39476 24-19)

16. EXPLORATIONS OF SUPERSONIC SHEAR FLOW OVER A CAVITY M. G. Scherberg p 291–314 (See N67-39477 24-12)

17. COMPUTATION OF THE COMPLEX ERROR FUNCTION BY CONTINUED FRACTIONS H. C. Thacher, Jr. (Argonne Natl. Lab.) p 315–337 refs (See N67-39478 24-19)

18. TRANSFORMATIONS TO ACCELERATE THE CONVERGENCE OF FOURIER SERIES P. Wynn (Wis. Univ.) p 339–379 refs (See N67-39479 24-19)

N67-39463# Aerospace Research Labs., Wright-Patterson AFB, Ohio.

CALCULATION OF TOROIDAL HARMONICS WITHOUT RECOURSE TO ELLIPTIC INTEGRALS

Henry E. Fettis *In its* Blanch Anniv. Vol. 21 Feb. 1967 p 21–34 (See N67-39461 24-19)

The transformation from rectangular to toroidal coordinates is presented, and the Laplace equation for this coordinate system is formulated. The properties of toroidal harmonics are defined in terms of the hypergeometric functions. Complete elliptic integrals are given to represent the toroidal harmonics, and a method is described which avoids both the stability problem and the necessity of computing explicitly any of the functions of lower order. This is based on the continued fraction for the ratio of functions of consecutive degree. A numerical example is included. M.G.J.

N67-39464# Rome Univ. (Italy).

GENERALIZED BIHARMONIC PROBLEM AND RELATED EIGENVALUE PROBLEMS

Gaetano Fichera *In* ARL Blanch Anniv. Vol. 21 Feb. 1967 p 35–44 refs (See N67-39461 24-19)

(Grant AF-EOAR-66-48)

A boundary value problem is considered which is the classical biharmonic type with homogeneous boundary conditions. The method described is based on the explicit construction of the Green operator G of the problem in terms of the linear operator T_b, and the adjoint operator T_b^*, and some projection operators. Two examples are given to satisfy the main hypothesis. It is shown that the technique is useful in solving the corresponding eigenvalue problem, and the generalized buckling eigenvalue problem. M.G.J.

N67-39465# Aerospace Research Labs., Wright-Patterson AFB, Ohio.

ON ERROR BOUNDS FOR THE SOLUTION OF SYSTEMS OF ORDINARY DIFFERENTIAL EQUATIONS

Karl G. Guderly and Marian Valentine *In its* Blanch Anniv. Vol. 21 Feb. 1967 p 45–89 refs (See N67-39461 24-19)

An approach to computing error bounds is discussed, which uses the residual obtained by inserting an approximate solution into the differential equation. It is assumed that the integration process yields some approximation of the solution which defines it everywhere in the region of integration. A norm or pseudonorm for the residuals is used, and an effort is made to determine the upper bounds for a norm of the deviation of the exact solution from the given approximation. To demonstrate the basic ideas, attention is focused on first order linear differential equations. It is shown that the choice of the norm determines a growth number which has a very pronounced influence on the obtainable bounds. Growth numbers are compared for the 2-norm, the infinity norm, and a pseudonorm. A procedure is derived for determining a pseudonorm for the errors incurred in the integration process, and details are given on how the bounding of the error norm can be combined with the integration of a system of differential equations. Examples of numerical experiments are included. M.G.J.

N67-39466# Aerospace Research Labs., Wright-Patterson AFB, Ohio.

SERIES EXPANSIONS FOR THE INCOMPLETE GAMMA FUNCTION AND ITS DERIVATIVES

H. Leon Harter *In its* Blanch Anniv. Vol. 21 Feb. 1967 p 91–97 refs (See N67-39461 24-19)

Several instances are cited in which series expansions for use in computing values of the incomplete gamma function and its first two derivatives are needed. Such an expansion for the incomplete gamma function is obtained by expanding e^{-t} in powers of t in the defining integral, then integrating term by term and evaluating. The first and second derivatives of the terms in this expansion are the corresponding terms in the series expansions for the first and second derivatives of the incomplete gamma function. Convergence of the series is discussed, and error bounds when the series are truncated after a specified number of terms are given. Author

N67-39467# Aerospace Research Labs., Wright-Patterson AFB, Ohio.

BOUNDS ON THE VALUE OF A DIRICHLET INTEGRAL REPRESENTING A COEFFICIENT OF APPARENT MASS

Charles L. Keller and Mark C. Breiter *In its* Blanch Anniv. Vol. 21 Feb. 1967 p 99–146 refs (See N67-39461 24-19)

Attention is centered on finding the upper and lower bounds on the numbers which denote the values of the contour integrals. Established Dirichlet principles are developed for determining the bounds on the apparent mass coefficients of a body cross section which is a unit circle with circular arc wings attached at the midpoints of the arcs lying in the first and second quadrants. The wing length is 3/8 of the circumference of the circle and the wings are attached at right angles to the body. A succession of transformations is described by sketches which show how the boundary is transformed. Coordinate functions and symmetry are considered, and the mapping sequences are described. The effect of inaccuracies in evaluating integrals is assessed, and the singularities in the transformed boundary conditions are discussed. The difficulties encountered in using the method are mentioned, and suggestions for improving the technique are proposed. M.G.J.

N67-39468# Aerospace Research Labs., Wright-Patterson AFB, Ohio.

SELECTION PROCEDURES BASED ON COVARIANCE MATRICES OF MULTIVARIATE NORMAL POPULATIONS

P. R. Krishnaiah *In its* Blanch Anniv. Vol. 21 Feb. 1967 p 147–160 refs (See N67-39461 24-19)

Consideration is given to the problem of selecting populations better than the standard when the underlying populations are multivariate normal. Selection procedures are described, based on: (1) variances of various variates when the off-diagonal elements of the correlation matrices are completely known; (2) a finite and infinite linear combinations of the elements of the covariance matrix; (3) determinants of the covariance matrices; and (4) the largest or smallest characteristic roots of the covariance matrices. Author

N67-39469# Midwest Research Inst., Kansas City, Mo.
RECURSION FORMULAS FOR POLYNOMIALS IN RATIONAL APPROXIMATIONS TO GENERALIZED HYPERGEOMETRIC FUNCTIONS
Yudell L. Luke *In* ARL Blanch Anniv. Vol. 21 Feb. 1967 p 161–187 refs (See N67-39461 24-19)

A recursion formula is derived for hypergeometric or extended Jacobi polynomials, based on the supposition that a certain relation exists between the number of numerator and denominator parameters. The confluence concept is discussed and applied to this formula. It is shown that the polynomial may be generated by a linear homogeneous difference equation. Proof is given that the numerator polynomial in the rational approximation satisfies an inhomogeneous difference equation whose homogeneous part is the same as that satisfied by the denominator polynomial. By using a free parameter, both the numerator and denominator polynomials satisfy the same recurrence equation. In the technique described, the error can be estimated by comparing the values of successive convergents. M.G.J.

N67-39471# Texas Univ., Austin.
GENERALIZED TRAPEZOID FORMULAS AND ERRORS IN ROMBERG QUADRATURE
Robert E. Lynch *In* ARL Blanch Anniv. Vol. 21 Feb. 1967 p 215–229 refs (See N67-39461 24-19)
(Grants NSF GP-5253; DA-ARO(D)-31-124-G721)

Based on the Euler–Maclaurin sum formula and the Blanch–Rhodes quadrature formula, a collection of similar quadrature formulas is generated. The error in the m-th of these is $O(h^{m+1})$, if m is odd, and each value of the integrand has unit weight except the first and the last m values. Values of the weight factors are listed for $m = 1,2,\ldots,11$, and the coefficient for the error bound terms is given. Error bounds for the Romberg quadrature are formulated, and the reliability of this error estimate is evaluated. M.G.J.

N67-39473# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
SOME COMPUTATIONAL ASPECTS OF THE TENSOR PRODUCT OF LINEAR PROGRAMS
Bertram Mond and Donald S. Clemm *In its* Blanch Anniv. Vol. 21 Feb. 1967 p 247–267 refs (See N67-39461 24-19)

Results obtained for the solution of the tensor product program are extended to additional types of linear programs including programs with mixed constraints. The emphasis is on the computational aspects of the decomposition theorems. A numerical example, run on an IBM 7094 computer, is cited. Such questions as the computational advantage to be derived by the use of a tensor product decomposition theorem in terms of memory space, number of iterations, significant digits retained and machine time needed are considered. Author

N67-39474# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
A DIFFERENCE INEQUALITY FOR OPERATORS IN HILBERT SPACE
Bertram Mond and O. Shisha *In its* Blanch Anniv. Vol. 21 Feb. 1967 p 269–275 refs (See N67-39461 24-19)

Based on previously published data, a theorem and proof is given for a Hilbert space generalization. Two examples are cited to show that for many values of r and s (real numbers), it is possible to solve for U^* explicitly, where U^* is the unique value in the open interval joining m^s and M^s. M.G.J.

N67-39476# Rose Polytechnic Inst., Terre Haute, Ind.
PRODUCTS AND QUOTIENTS OF GENERALIZED CAUCHY VARIABLES
Paul R. Rider *In* ARL Blanch Anniv. Vol. 21 Feb. 1967 p 285–289 refs (See N67-39461 24-19)

The distributions of product and quotient of random variables from a population characterized by a probability density function are derived. The generalized results prove the Cauchy distribution. M.G.J.

N67-39478# Argonne National Lab., Ill.
COMPUTATION OF THE COMPLEX ERROR FUNCTION BY CONTINUED FRACTIONS
Henry C. Thacher, Jr. *In* ARL Blanch Anniv. Vol. 21 Feb. 1967 p 315–337 refs Sponsored by AEC (See N67-39461 24-19)

The more useful properties and relations involving the complex error function are reviewed, and the properties of the Taylor continued fractions are discussed and compared with data for the Laplace fraction. Tabulations are included on the number of convergents of continued fractions and terms of Taylor series for 10 decimal accuracy; the magnitudes of differences between values of $w(x+iy)$ with Taylor fractions evaluated in single and double precision; the magnitude of difference between Taylor and Laplace continued fractions; the number of convergents of Taylor and Laplace fractions required for 25D convergence; and the number of convergents to attain error estimate less than 5×10^{11}. Numerical test results are plotted and assessed. M.G.J.

N67-39479# Wisconsin Univ., Madison. Mathematics Research Center.
TRANSFORMATIONS TO ACCELERATE THE CONVERGENCE OF FOURIER SERIES
P. Wynn *In* ARL Blanch Anniv. Vol. 21 Feb. 1967 p 339–379 refs (See N67-39461 24-19)

A comparative review is presented of methods for accelerating the numerical convergence of Fourier series. The various reasons for which Fourier series either diverge or converge sufficiently slowly to render them useless for computation are discussed and, where possible, an appropriate convergence acceleration transformation is prescribed. Particular emphasis is placed upon the use of continued fractions, which appears at the same time to have the widest domain of application and to be the most powerful general method available. Author

N67-39487# Wisconsin Univ., Madison. Mathematics Research Center.
ON THE HOLDER CONTINUITY OF AN INTEGRAL INVOLVING BESSEL FUNCTIONS
S. T. Kuroda Mar. 1967 22 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-745; AD-657578)

With the aim of using in an argument in the study of the spectrum of the Schrodinger operators, a particular integral involving the Bessel functions and depending on a parameter is considered. The main purpose is to investigate the continuity property of the integral with respect to the parameter. It is shown that it is Holder continuous with the exponent large enough for the purpose of the application and that the Holder continuity is uniform with respect to the order of the Bessel function involved. The second point constitutes the major part of the discussion. Author (TAB)

N67-39488# Wisconsin Univ., Madison. Mathematics Research Center.
MATRIX LINKS, AN EXTREMIZATION PROBLEM, AND THE REDUCTION OF A NON-NEGATIVE MATRIX TO ONE WITH PRESCRIBED ROW AND COLUMN SUMS
M. V. Menon Jun. 1967 19 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-651; AD-657579)

If alpha is the class of non-negative m x n matrices A of a given pattern, with a11 = 0 and with prescribed i th row sum and j th column sum, i, j>1, certain matrix operations are defined which when applied to each A a member of alpha lead to two matrices whose first row sums equal Sup(subscript A a member of alpha) (first row sum of A) and Inf(subscript A a member of alpha) (first row sum of A). This result is used in the proof of the following one. Let A* be a given non-negative matrix. Let alpha be the class of non-negative matrices of the same pattern as A* and with all its row and column sums prescribed. If alpha is not empty, there exists a unique A a member of alpha and two diagonal matrices U and V such that A* = UAV. TAB

N67-39512# California Univ., Berkeley. Operations Research Center.
LIKELIHOOD RATIO TESTS FOR RESTRICTED FAMILIES
Richard E. Barlow Apr. 1967 36 p refs
(Contract Nonr-3656(18))
(ORC-67-16; AD-653104)

Likelihood ratio tests for the problem Ho:FϵF$_1$ versus H$_1$:FϵF--F$_1$ are defined for certain nonparametric families of distributions F and F$_1$. In particular the likelihood ratio test is defined and shown to be unbiased when F$_1$ denotes the exponential distributions (possibly truncated) and G denotes the distributions with increasing failure rate. Comparisons are made with increasing failure rate. Comparisons are made with competing tests. The problem of testing for increasing failure rate avarage is also examined. Author (TAB)

N67-39524# Wisconsin Univ., Madison. Mathematics Research Center.
SPECTRAL ANALYSIS OF COLLECTIVELY COMPACT, STRONGLY CONVERGENT OPERATOR SEQUENCES
P. M. Anselone and T. W. Palmer Apr. 1967 17 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-741; AD-657568)

A set H of operators on a Banach space X is collectively compact iff (Kx: K epsilon H, Norm x = or < 1) is precompact. Operators T and T sub n, n = or > 1, such that T sub n approaches T strongly and (Tn -T) is collectively compact are investigated. The spectrum of Tn is eventually contained in any given neighborhood of the spectrum of T. If f(T) is defined by the operational calculus, then f(Tn) is eventually defined, f(Tn) approaches f(T) strongly, and (f(Tn) - f(T)) is collectively compact. If f(Tn) and f(T) are spectral projections, the corresponding structural subspaces eventually have the same dimension. Other results compare eigenvalues and generalized eigenmanifolds of Tn and T. Author (TAB)

N67-39542# Michigan State Univ., East Lansing. Dept. of Statistics and Probability.
ON INCIDENCE MATRICES
Peter C. C. Wang 31 Aug. 1967 14 p refs
(Contract Nonr-2587(02))
(RM-197; PCCW-6; TR-18; AD-657611)

Given an m×n incidence matrix A(m,n), it is desired to 'squeeze' as many of its 1's as possible into its upper left-hand corner by a sequence of row and column permutations. Such a problem arises in designing switches for computers. To establish criteria for the optimal matrix of the class of row and column permutations, we assign a weight W$_{ij}$ to each position in the original matrix where W$_{ij}$ is the weight assigned to the i-th row, j-th column position. The weight of matrix A(m,n) = (A$_{ij}$) is taken to be summation, 1≤i≤m, 1≤j≤n, of (A$_{ij}$ W$_{ij}$). Suppose W$_{ij}$ A(m,n) are given, then denote P(A) the permutation derived matrices of A, then the problem is to find max (A epsilon P(A)) summation, 1≤i≤m, 1≤j≤n, of (A$_{ij}$ W$_{ij}$). In particular, when W matrix is square and A is the identity matrix, then this problem is reduced to the well-known assignment problem. Author (TAB)

N67-39557# Michigan State Univ., East Lansing. Dept. of Statistics and Probability.
FUNCTIONS OF PROCESSES WITH MARKOVIAN STATES
Martin Fox and Herman Rubin 21 Aug. 1967 11 p refs
(Contracts AF 19(628)-355; Nonr-2587(02))
(RM-193; MF-8; HR-19; TR-17; AD-657176)

Given a process (Yn), let epsilon be a state of finite rank. An example is given in which Yn = f(Xn), (Xn) is countable state, stationary, Markov, (Yn) is stationary with one state each of ranks 1 and 3, yet it is impossible to take (Xn) to be finite state Markov. In general it is proved that Yn = f(Xn) where epsilon = f(epsilon i) (i = 1,2,...), delta = f(delta) for delta not equal to epsilon and the epsilon i are Markovian states. If epsilon has rank 2 it is proved that two states suffice and that the rank of delta not equal to epsilon in (Xn) is the same as in (Yn). Finally, it is proved that if epsilon has rank 2 and (Yn) is stationary, (Xn) is stationary. Author (TAB)

N67-39559# Research Analysis Corp., McLean, Va.
THEORY OF LAGRANGE MULTIPLIERS FOR CONSTRAINED OPTIMIZATION PROBLEMS
James E. Falk Jul. 1967 31 p refs
(Contract DA-44-188-ARO-1)
(RAC-TP-262; AD-658068)

The paper treats an extension of one version of the classical Lagrange multiplier rule as applied to nonlinear programming problems. For a given problem, an auxiliary problem is defined and its properties are studied under various assumptions. In particular, when the given problem has a strictly convex objective function and concave constraints it is shown that the auxiliary problem is one of maximizing a concave differentiable function over an open set subject only to nonnegativity conditions. Some applications of this theory are presented only with the connection between the auxiliary problem and a dual of the given problem. Author (TAB)

N67-39574*# Massachusetts Inst. of Tech., Cambridge. Electronic Systems Lab.
THE MATRIX MINIMUM PRINCIPLE
Michael Athans Aug. 1967 19 p refs
(Grant NGR-22-009-124)
(NASA-CR-89628; ESL-R-317) CFSTI: HC $3.00/MF $0.65 CSCL 12A

The purpose of this report is to provide an alternate statement of the Pontryagin maximum principle as applied to systems which are most conveniently and naturally described by matrix, rather than vector, differential or difference equations. The use of gradient matrices facilitates the manipulation of the resultant equations. The theory is applied to the solution of a simple optimization problem. Author

N67-39632# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
NUMERICAL INTEGRATION METHODS FOR BALLISTIC ROCKET TRAJECTORY SIMULATION PROGRAMS
Randall K. Walters Jun. 1967 40 p refs
(ECOM-5134; AD-658064)

Numerical integration methods for solution of the system of differential equations found in ballistic rocket trajectory programs are discussed. The general discussion entails the explicit formulas of Runge-Kutta and predictor-corrector methods and their errors, and a brief description of other methods that could be employed. Author (TAB)

N67-39633# Wisconsin Univ., Madison. Mathematics Research Center.

A NOTE ON THE CONVERGENCE OF CERTAIN NON-COMMUTATIVE CONTINUED FRACTIONS

P. Wynn May 1967 17 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-750; AD-657577)

It is assumed that the coefficients of a non-commutative continued fraction are members of a normed ring; the supremum norm of A is denoted by Gamma(A), the infinimum norm by lambda(A). If gamma(c sub 2) + gamma(c sub 3) + summation, s=4 to s=r, of the following: gamma(c sub 5)(1 + gamma(c sub 2)) (1 + gamma(c sub 3))...(1 + gamma(c sub(s-2)))<1 then the convergents of both continued fractions pre(c sub 0 + (c sub 1/1+)(c sub 2/1+)...) and post(c sub 0 + (c sub 1/1+)(c sub 2/1+)...) exist, and both continued fractions converge uniformly. A further convergence result is derived. TAB

N67-39666# Rand Corp., Santa Monica, Calif.

IMPLICIT ENUMERATION USING AN EMBEDDED LINEAR PROGRAM

A. M. Geoffrion Sep. 1967 20 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5406-PR; AD-658814)

The report discusses a zero-one integer linear programming code for solving a general class of discrete optimization problems. The code is designed for problems of up to 90 binary variables and 50 constraints. Two main approaches are used to reduce computing time: (1) periodic application of linear programming to continuous approximations to subproblems generated by partial solutions; (2) periodic introduction of composite redundant constraints. By introducing a measure of strength, strong composite constraints can be computed by linear programming. TAB

N67-39667# Eidgenössische Technische Hochschule, Zürich (Switzerland).

ON THE MULTIDIMENSIONAL THEORY OF ITERATIONS [UEBER DIE MEHRDIMENSIONALE THEORIE DER ITERATIONEN]

Fulco Lock (Ph.D. Thesis) 1966 132 p refs In GERMAN
(DISS-3805) CFSTI: HC $3.00/MF $0.65

This work is based on the calculation of the first two cumulants of duplet distribution and the first four cumulants of the distribution of the alternates on a rectangular lattice. A theorem on factorial moments is generalized to apply to a finite sum of dependent or independent stochastic variables. This theorem is used to derive equations for the first four cumulants of duplet distribution, i.e., the mean, the variance, the third cumulant, and the fourth cumulant of distribution. Next, the equations are applied to various lattices, such as the one-dimensional rectangular lattice with and without diagonals. For the two-dimensional rectangular lattice with boundary conditions, mean and variance were calculated for the following five distributions: quadruplets with and without diagonals, quintuplets without diagonals, and duplets and triplets of connections without diagonals. For the plane hexagonal lattice with boundary conditions, the following were calculated: distribution mean and variance of duplets, triplets, quadruplets, duplets and triplets with connections, and the first four cumulants of alternate distributions in case of two characteristics. Results from the combinatorial and probability theories were used in the calculations. Transl. by K.W.

N67-39677# Wisconsin Univ., Madison. Mathematics Research Center.

ASYMPTOTIC ESTIMATES OF THE L_2n-WIDTH

Joseph W. Jerome Apr. 1967 24 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-746; AD-657574)

For classes of functions of m variables satisfying a quadratic inequality involving the L sub 2-norm of derivatives up to a given order k, asymptotic estimates are given for the n-widths. They involve upper and lower inequalities of the form (lc/n) to the k/m power) + O(n to the -k/m power) as n approaches infinity, where ce is a positive constant which can be estimated. TAB

N67-39689# California Univ., Berkeley. Operations Research Center.

HOW TO SOLVE LINEAR INEQUALITIES

David Gale Jul. 1967 22 p refs
(Contract Nonr-222(83); Grant NSF GP-7417)
(ORC-67-26; AD-658095)

This paper is an attempt to solve the following constrained minimum problem: To present the most easily described algorithm for solving linear inequalities subject to the constraints, (1) The algorithm must be efficient. (2) It must be shown to terminate. The algorithm is a variant of the lexicographic simplex method which avoids using any artificial objective function. Author (TAB)

N67-39691*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

ITERATIVE INTERPOLATION AND NUMERICAL DIFFERENCES

E. R. Lancaster Oct. 1967 8 p refs
(NASA-TM-X-55976; X-643-67-510) CFSTI: HC $3.00/MF $0.65 CSCL 12A

An iterative method of interpolation based on divided differences is developed which is about three times as fast as the iterative methods of Aitken and Neville. The method is extended to numerical differentiation, with similar improvements over Hunter's extension of the Aitken and Neville methods. Author

N67-39701# California Univ., Berkeley. Operations Research Center.

SENSITIVITY ANALYSIS IN MULTITERMINAL FLOW NETWORKS

Francisco K. Rado Jun. 1967 50 p refs
(Contract DA-31-124-ARO(D)-331; Grant NSF GK-1684)
(ORC-67-22; AROD-5307-26-M; AD-658510)

Algorithms are given for determining the influence of varying the capacity of an arc or of several arcs with linearly related capacities, on the maximal flows between every pair of nodes in an undirected network. This work builds upon the fundamental work of Gomory and Hu, and is closely related to the approach of Elmaghraby, who also gives algorithms for solving these problems. Author (TAB)

N67-39704# Wisconsin Univ., Madison. Mathematics Research Center.

UPON THE PADE TABLE DERIVED FROM A STIELTJES SERIES

P. Wynn Jun. 1967 61 p refs
(Contract DA-31-124(ARO)462)
(MRC-TSR-720; AD-657573)

The paper is concerned with the Pade table constructed from a series Summation, s = 0 to s = infinity, of ((-1) to the s power (c subscript s) (z superscript s)) whose coefficients are given by c subscript s = the integral from 0 to infinity of the quantity (u to the s power) d psi (u), where psi (u) is a bounded non-decreasing function in 0 = or < u = or < infinity. It is shown that under certain conditions, when z is real and positive, the Pade quotients along both forward and backward diagonals from monotonic sequences; an optimal property of the quotients lying upon the principal diagonal is proved. Some new convergence results are derived. The Pade quotients are compared with the transformed sums produced by certain linear methods. Author (TAB)

N67-39705# Wisconsin Univ., Madison. Mathematics Research Center.
COLLECTIVELY COMPACT SETS OF LINE OPERATORS
P. M. Anselone and T. W. Palmer Apr. 1967 14 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-740; AD-657569)

A set of linear operators from one normed linear space to another is collectively compact if the union of the images of the unit ball is precompact. Several criteria for sets of operators to be collectively compact are given. It is shown that a compact set of compact operators is collectively compact, but not conversely. For a set H of compact normal operators on a Hilbert space, H is collectively compact if H is totally bounded if H* + (K* : K epsilon H) is collectively compact. For any set H of compact operators on a Hilbert space, H is totally bounded if H and H* are collectively compact. The proof of these assertions depends on some interesting properties of the spectral decomposition of the operators. Author (TAB)

N67-39707# Wisconsin Univ., Madison. Mathematics Research Center.
CONSTRUCTION OF EIGENFUNCTION EXPANSIONS BY THE PERTURBATION METHOD AND ITS APPLICATION TO N-DIMENSIONAL SCHROEDINGER
S. T. Kuroda May 1967 61 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-744; AD-657566)

An operator-theoretical approach to the construction of eigenfunction expansions by the perturbation method is discussed. Eigenfunction expansions in this paper mean those associated with continuous spectra. The method is to combine a stationary approach to the scattering theory with the now well developed idea of formulating generalized eigenfunction expansions in terms of a triplet of spaces. Given an expansion associated with the unperturbed operator, two complete sets of eigenfunctions of the perturbed operator are constructed and shown to be the unique solution of the Lippmann-Schwinger equation in a modified form. As an application, spectral properties of the n-dimensional Schrodinger operator -delta + f(x) are investigated in detail. TAB

N67-39708# Wisconsin Univ., Madison. Mathematics Research Center.
SUMMATION OF SERIES OF POSITIVE TERMS BY CONDENSATION TRANSFORMATIONS
James W. Daniel Apr. 1967 17 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-743; AD-657567)

The condensation transformation, which maps series of positive terms into more conveniently summed alternating series, each term v sub j of which is itself an infinite series, is discussed with examples. It is shown that for a large class of extremely slowly convergent series (essentially those dominated by the logarithmic scale) the series defining the terms v sub j are more easily summed than the original and may in fact be transformed further if desired. Numerical examples reveal the power of the method. Author (TAB)

N67-39781# Naval Weapons Lab., Dahlgren, Va.
MODELS FOR MATHEMATICAL SYSTEMS II
Alfred H. Morris, Jr. Aug. 1967 22 p Suppl. to NWL-2032
(NWL-K-45/67; NWL-2032; AD-657840)

The paper is a supplement to the paper Models for Mathematical Systems, by A. H. Morris, Jr., AD-637 127. The multiplication and exponentiation operations for an arbitrary associative algebra are first examined, the resulting analysis being applied in a detailed treatment of the SIMPLIFY, MULT, and MULTILINEAR rings. Author (TAB)

N67-39837# Stanford Univ., Calif. Dept. of Computer Science.
WHAT IS A SATISFACTORY QUADRATIC EQUATION SOLVER?
George E. Forsythe 7 Aug. 1967 13 p refs Presented at the Symp. on Constructive Aspects of the Fundamental Theorem of Algebra at IBM Res. Labs., Rueschlikon, Switzerland, 5–7 Jun. 1967
(Contract Nonr-225(37))
(CS-74; AD-657639)

The report discusses precise requirements for a satisfactory computer program to solve a quadratic equation with floating-point coefficients. The principal practical problem is coping with overflow and underflow. TAB

N67-39870# Universidad Nacional de Colombia, Bogota. Facultad de Ciencias.
NOMOGRAPH SEMINAR [SEMINARIO DE NOMOGRAFIA]
1967 83 p refs In SPANISH Conf. held at Bogota, 1965 *Its* Publ. No. 1
CFSTI: HC $3.00/MF $0.65

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N67-39871# Universidad Nacional de Colombia, Bogota. Facultad de Ciencias.
NOMOGRAMS [NOMOGRAMAS]
Guillermo Diaz Santanilla *In its* Nomograph Seminar 1967 p 9–30 refs (See N67-39870 24-19)

A nomogram is a graphic or line chart representation of a mathematical equation which permits solutions to be obtained using only geometric elements. There are three types of nomograms according to the mathematical principle of their construction: Cartesian nomograms of intersection, linear nomograms, and linear and intersecting nomograms. The construction of these three types of nomograms is described. Transl. by R.N.A.

N67-39872# Universidad Nacional de Colombia, Bogota. Facultad de Ciencias.
ON A REPRESENTATION OF A CLASS OF FUNCTIONS DIFFICULTLY REDUCED TO A NOMOGRAPHIC DETERMINANT [SOBRE UNA REPRESENTACION DE UNA CLASE DE FUNCIONES DIFICILMENTE REDUCTIBLES A DETERMINANTE NOMOGRAFICO]
Eduardo A. Caro Cayzedo *In its* Nomograph Seminar 1967 p 31–34 (See N67-39870 24-19)

The nomograms in N can be used to represent relations of the type $f_1(x)/f_2(y) = f_3(z)$, assuming that $f_3(z) = z$. In these

nomograms the values of the variable z remain nonuniformly represented on the diagonal support. If at the scale which carries the values of z another is added with the values of a new variable w related with the former by the expression F(w) = G(z), a nomographic representation is found of a relation of the form F(w) = $G(f_1(x)/f_2(y))$ which is interesting for treating an expression which is not always easily reducible to a nomographic determinant, and which for the same reason, in appearance, is not susceptible to solution by means of a nomogram of linear points. Two examples are given using a method which employs a nomogram of parallel scales. Transl. by R.N.A.

N67-39874# Universidad Nacional de Colombia, Bogota. Facultad de Ciencias.

A SHORT HISTORY OF A NOMOGRAM [PEQUENA HISTORIA DE UN NOMOGRAMA]

Eduardo A. Caro Cayzedo *In its* Nomograph Seminar 1967 p 47–54 (See N67-39870 24-19)

The formulas used in the construction of a nomogram are derived and the determinate obtained is shown in the various nomograms that were used until a suitable one was found. Transl. by R.N.A.

N67-39875# Universidad Nacional de Colombia, Bogota. Facultad de Ciencias.

ERRORS IN READING NOMOGRAMS [ERRORES DE LECTURA EN LOS NOMOGRAMS]

Marijan Bomhard Badovinac *In its* Nomograph Seminar 1967 p 55–60 (See N67-39870 24-19)

A semigraphic method for finding the reading error of nomograms constructed totally or in part is described. The imprecise readings are due to the inaccuracies in the construction of the nomogram, because of imprecisions with which one elaborates the matrix. They are also due to the imprecise determination of the fractions of intervals between one line and the next at the moment of reading. The method, which consists of two variations, always gives the maximum possible error. Transl. by R.N.A.

N67-39876# Universidad Nacional de Colombia, Bogota. Facultad de Ciencias.

CRITERIA FOR IMPROVING THE SCALES OF A NOMOGRAM [UN CRITERIO PARA MEJORAR LAS ESCALAS DE UN NOMOGRAMA]

Marijan Bomhard Badovinac *In its* Nomograph Seminar 1967 p 61–64 (See N67-39870 24-19)

Reading errors encountered in different measuring instruments, a mode for expressing the results of a measurement, and the divisions of the nomogram which are affected by the reading error of an instrument are discussed. Transl. by R.N.A.

N67-39882# System Development Corp., Santa Monica, Calif.

CONVERGENCE OF THE VON ZEIPEL PROCEDURE

Richard B. Barrar 20 Jul. 1967 21 p refs
(SP-2810/000/01; AD-658479)

Although it has long been realized that the von Zeipel procedure is an accurate method for solving problems in celestial mechanics, no mathematical proofs have been available to show that it actually converged. Recently such proofs have been given by Arnold and Barrar. The present paper is devoted to still another proof, much simpler than those previously given. The proof is based on a suggestion of A. N. Kolmogorov in the 1954 Doklady. Author (TAB)

N67-39887# System Development Corp., Santa Monica, Calif.

ON THE CONSTRUCTION OF ORTHOGONALIZED SQUARES BY FINITE FIELDS

N. E. Willmorth 26 Jul. 1967 18 p refs
(SP-2897; AD-658468)

Comment concerning a recent paper (1) on the confounded factorial approach to the construction of incomplete block designs indicates the desirability of considering other, less complex, construction methods. This paper is limited to the finite field approach to the generation of orthogonalized squares. Three general cases are discussed: (a) where the number of elements, m, in a row or column of a square is a prime; (b) where m is the power of a prime; and (c) where m is a product of several primes or powers of primes. These three cases, of course, cover all positive integers. The construction methods are limited, however in that while the minimum number of orthogonalized squares is determined by the least prime power law (i.e., s = min(p superscript i - 1), where s is the number of squares and p superscript i is the smallest number in the product m = (p superscript i)(p superscript j)(p superscript k), the maximum number of squares is not directly determinable. For instance, in cases where the least prime power is equal to 2 (i.e., p superscript i = 2, and, in general, numbers of the form 4k + 2), it was long thought that not even orthogonal pairs of squares existed. However, although at least pairs of squares have been found for such cases using other methods, these methods are not covered here. Author (TAB)

N67-39902* Scientific Translation Service, La Canada, Calif.

APPLICATION OF THE METHOD OF PARAMETER VARIATION TO THE THEORY OF NONLINEAR FUNCTIONAL EQUATIONS

D. F. Davidenko Washington, NASA, Oct. 1967 13 p refs Transl. into ENGLISH from Ukr. Mat. Zh. (Kiev), v. 7, no. 1, 1955 p 18–28
(Contract NASw-1496)
(NASA-TT-F-11273) CSCL 12A

The parameter variation method is applied to nonlinear functional equations, with nonlinear integral equations treated as a special case. Author

N67-39934# Ballistic Research Labs., Aberdeen Proving Ground, Md.

ON STEPWISE MULTIPLE LINEAR REGRESSION

Harold J. Breaux Aug. 1967 53 p refs
(BRL-R-1369; AD-658674)

Stepwise multiple linear regression has proved to be an extremely useful computational technique in data analysis problems. This procedure has been implemented in numerous computer programs and overcomes the acute problem that often exists with the classical computational methods of multiple linear regression. This problem manifests itself through the excessive computation time involved in obtaining solutions to the (2 to the Nth power -1) sets of normal equations that arise when seeking an optimum linear combination of variables from the subsets of the N variables. The procedure takes advantage of recurrence relations existing between covariances of residuals, regression coefficients, and inverse elements of partitions of the covariance matrix. The application of these recurrence formulas is equivalent to the introduction or deletion of a variable into a linear approximating function which is being sought as the solution to a data analysis problem. This report contains derivations of the recurrence formulas, shows how they are implemented in a computer program and includes an improved algorithm which halves the storage requirements of previous algorithms. A computer program for the BRLESC computer which incorporates this procedure is described by the author and others in a previous report, BRL Report No. 1330, July 1966. The present report is an amplification of the statistical theory and computational procedures presented in that report in addition to the exposition of the improved algorithm. Author (TAB)

N67-40034# Texas Univ., Austin. Computation Center.
MATRIX SCALING WITH RESPECT TO THE MAXIMUM-NORM, THE SUM-NORM, AND THE EUCLIDEAN NORM
Peter Arthur Businger (Ph.D. Thesis) Aug. 1967 123 p refs
(Grants DA-ARO(D)-31-124-G721; NSF GP-5253)
(ITR-15; AD-658675)

The condition number of a nonsingular matrix A with respect to the inversion problem and with respect to a vector norm is defined by cond(A) = lub(A)lub(A superscript-1), where lub(.) denotes the matrix bound subordinate to the norm. The spectral condition number can be regarded as a measure by which A fails to be a scalar multiple of a unitary matrix. Other such measures are considered and related to cond(A). TAB

N67-40056# Carnegie Inst. of Tech., Pittsburgh, Pa. Management Sciences Research Group.
A NOTE ON SOME STOCHASTIC APPROACHES TO NONSTOCHASTIC DISCRETE PROGRAMMING
Fred Glover Aug. 1967 16 p refs
(Contract Nonr-760(24))
(RR-111; AD-657431)

Some ways are proposed for assigning best probabilities to the values assumed by the variables of a deterministic integer linear programming problem. Our results, which can be used in the framework of the Reiter and Rice discrete optimization procedure and the Graves and Whinston confidence level procedure, also give meaningful conditional probabilities and suggest other stochastic approaches to discrete linear programming. Author (TAB)

N67-40062# Carnegie Inst. of Tech., Pittsburgh, Pa. Management Sciences Research Group.
ON THE APPLICATION OF THE THEORY OF MAXIMUM PRINCIPLE TO A PRODUCTION CONTROL PROBLEM
R. Jagannathan Aug. 1967 14 p refs
(Contract Nonr-760(24))
(RR-108; AD-657430)

The purpose of this paper is to solve a simple production control problem using the maximum principle theory as put forward by L. S. Pontryagin and his students. In the first section entitled Introduction, a brief description of maximum principle theory as relevant to our purpose is given. In the second section the production scheduling problem under probabilistic demand (which occurs periodically) is developed. The problem is a fairly realistic one resulting in a somewhat complicated analysis. In the final section the possibilities of relaxation of some of the underlying assumptions are indicated. Author (TAB)

N67-40141# Eidgenossische Technische Hochschule, Zurich (Switzerland).
ON THE LUSTERNIK–SCHNIRELMANN CATEGORY OF SPACE FIBERS AND LIE GROUPS [SUR LA CATAGORIE DE LUSTERNIK–SCHNIRELMANN DES ESPACES FIBRES ET DES GROUPES DE LIE]
Marcel A. F. Deruaz (Ph.D. Thesis) 1967 32 p refs In FRENCH
(THESE-3855) CFSTI: HC $3.00/MF $0.65

The Fox definition for the category of a topological space and its difference from the Lusternik–Schnirelmann categorization is discussed, along with methods of estimating categories of function spaces and Lie groups. Possible application and a cohomological multiplicative arbitrary theory are generalized. Inequalities in these spaces are demonstrated for several cases, and the category of a compact Lie group is evolved. Categories are estimated for some SU, Spin, Sp, U, and SO groups; and homogeneous space categories are also considered.
Transl. by M.W.R.

N67-40154# Carnegie Inst. of Tech., Pittsburgh, Pa. Management Sciences Research Group.
AN ALGORITHM FOR FINDING A MINIMUM EQUIVALENT GRAPH OF A DIGRAPH
Dennis M. Moyles and Gerald L. Thompson Jul. 1967 13 p refs
(Contract Nonr-760(24))
(RR-107; AD-657428)

A directed graph or digraph can be thought of as a communication network among a set of persons, where the vertices of the graph correspond to persons and edges of the graph to directed channels of communication from one person to another. A person is said to be able to reach another if he can send a message to that person. The present paper gives an algorithm for finding the maximum number of edges that can be removed from a digraph without affecting its reachability properties.
Author (TAB)

N67-40206 Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
ROTATION AND LORENTZ GROUPS IN A FINITE GEOMETRY
E. G. Beltrametti and A. A. Blasi 1967 26 p refs
(RT/F1(67)18)

It has been pointed out that, in principle, there are no fundamental objections to the idea of building up a description of physical phenomena by taking the space-time coordinates from a finite field instead of taking them, as usual, from the real-number field. Though the finite geometry so generated is nonmetric as a whole, it may contain a subset approximating, with an unlimited accuracy, the ordinary Euclidean geometry. The general features of the simple relativity groups in the framework of a finite geometry built over a finite field GF(p) are examined. Quoted are some relevant properties of finite fields, also called Galois field. The structure and representations of the rotation group are analyzed, and the analysis is extended to the Lorentz and Poincaré groups.
Author

N67-40245# Illinois Univ., Urbana.
CONVOLUTION ALGEBRAS ON LOCALLY COMPACT SPACES
William W. Fairchild (Ph.D. Thesis) Mar. 1967 68 p refs
(Contract DA-31-124-ARO-D-288)
(AROD-5254.11-M; AD-658992)

The work continues the investigations which concern themselves with generalizations of the classical notion of convolution on topological groups. That such generalizations are warranted is clear from various examples, for instance those arising from differential equations, central functions, groups and semi-groups of operators, Delsarte translation operators, and hypercomplex systems.
TAB

N67-40291 Joint Publications Research Service, Washington, D. C.
CERTAIN CHARACTERISTICS OF A DECISION MODEL ALGORITHM OF LEONT'YEV TYPE
V. Z. Belen'kiy 11 Oct. 1967 6 p Transl. into ENGLISH of the Russian Paper "Nekotoryye Svoystva i Algoritm Resheniya Modeli Tipa Leont'yeva" Presented at the Intern. Congr. of Management Sci., Mexico City, 1967
(JPRS-42926; TT-67-33552; Rept.-14) CFSTI: $3.00

A mathematical analysis is presented on problems pertaining to the method of interbranch balance used in planning economic activities. Variations of a model of prospective planning are formulated, and an extremely simple algorithm for locating the minimum point of set D is given in the form of theorems. It is reported that from the results obtained a solution was found to the nonlinear model of perspective planning of the national economy

on the assumption of constant rates of growth of branches during the planning period, with the criterion of maximum growth rate of consumption. M.G.J.

N67-40323# Stanford Univ., Calif. Dept. of Operations Research.
DUALITY IN DISCRETE PROGRAMMING
Egon Balas Aug. 1967 26 p refs Revised
(Contracts DAHC04-67-C-0028; N00014-67-A-0112-0011; AT(04-3)-326; Grant NSF GP-6431)
(TR-67-5; AD-658740)

A duality theory is proposed for discrete programming. The mixed-integer programming problem is shown to be a special case of a minimax problem with a Lagrangian-type objective function, linear constraints, and some variables constrained to belong to an arbitrary set of real numbers. The dual of this problem is formulated as a problem of the same type, and such that the dual of the dual is the primal. It is shown that the primal has an optimal solution if and only if the dual has one, and in this case the values of their respective objective functions are equal. An optimal solution to the primal and the dual is shown to have the saddle-point property of optimal solutions to a pair of dual linear (and certain nonlinear) programs. A certain type of complementary slackness is shown to hold. Conditions for the uniqueness of a solution are examined. Finally, an economic interpretation is outlined in terms of a generalized shadow-prince system for mixed-integer programs. TAB

N67-40396*# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
FUNCTION MINIMIZATION WITHOUT DERIVATIVES BY A SEQUENCE OF QUADRATIC PROGRAMMING PROBLEMS
David H. Winfield Aug. 1967 21 p refs
(Grant NGR-22-007-068; Contract Nonr-1866(16))
(NASA-CR-89751; TR-537) CFSTI: HC $3.00/MF $0.65 CSCL 12A

An algorithm is described for minimizing an arbitrary scalar cost function $c(x)$ with respect to an n-vector x. At each stage of the minimization, the cost function is approximated by a quadratic form in the region about the current lowest-cost point. The next trial point is taken as the minimum of this quadratic form within a hypercube in n-space centered at the current lowest-cost point. The procedure has quadratic convergence, but differs from other quadratically convergent minimization algorithms in that (a) minimization is over a sequence of n-dimensional regions rather than over a sequence of one-dimensional straight lines (b) the local approximation to the cost surface need not be positive definite (c) each approximation depends only on true cost values and is independent of prior approximations, (d) after each evaluation of cost at a trial point, the trial point is added, and a point distant from the current lowest-cost point is deleted, from the set of points to which the next quadratic form will interpolate. The algorithm takes relatively large steps, and is forced to learn from its failures. Test results are presented for $n=2$ using Rosenbrock's parabolic valley as the cost function. Author

N67-40484# Purdue Univ., Lafayette, Ind. Dept. of Statistics.
OPTIMAL DESIGNS ON TCHEBYCHEFF POINTS
William J. Studden Sep. 1967 29 p refs *Its* Mimeograph Ser.-118
(Contracts Nonr-1100(26); F33615-67-C-1244)
(AD-659064)

Kiefer and Wolfowitz (1959) proved that the optimal design for estimating the highest coefficient in polynomial regression is supported by certain Tchebycheff points. Hoel and Levine (1964) showed that the optimal designs for extrapolation in polynomial regression were all supported by the Tchebycheff points. These results were extended by Kiefer and Wolfowitz (1965) to cover nonpolynomial regression problems involving Tchebycheff systems and the large class of designs supported by the Tchebycheff points was characterized. In the present paper it is shown that the optimal design for estimating any specific parameter is supported by one of two sets of Tchebycheff points. Different proofs of the Kiefer-Wolfowitz results are also presented. Author (TAB)

N67-40488# Weibull (Waloddi), Lausanne (Switzerland).
APPROXIMATIONS OF BEST LINEAR, UNBIASED ORDER-STATISTIC ESTIMATORS Scientific Report, Feb. 1966–Feb. 1967
Waloddi Weibull Wright-Patterson AFB, Ohio. AF Mater. Lab., Jun. 1967 38 p
(Contract AF 61(052)-943)
(AFML-TR-67-198; SR-3; AD-658845)

Formulas for two types of approximations of the best linear, unbiased order-statistic estimator, both dispensing with the covariance matrices, have been developed and applied to the y- and z-estimators. Extensive tables for the coefficients of these estimators, their variances and covariances have been accomplished by use of an IBM 7090 computer. The efficiencies of the approximations in relation to the exact solutions have been determined for various sample sizes and shape parameters. A measure of goodness of fit has been proposed, and its mean, percentiles and variance has been determined by use of a Monte-Carlo study, involving ten thousand random samples for each of thirteen sample sizes from N = 3 to 100. Author (TAB)

N67-40473*# Denver Univ., Colo.
RELATIVISTIC SPACE-TIMES HAVING CORRESPONDING GEODESICS Final Report
Gareth Williams Oct. 1967 23 p refs
(Grant NsG-518)
(NASA-CR-89771) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Pairs of relativistic space-times are classified according to their Segre characteristics. Suitable bases consisting of pseudo-orthonormal tetrads are constructed and the condition that the spaces should have corresponding geodesics is imposed. It is found that the [3,1] and [(3,1)] classes contain spaces with corresponding geodesics. The most general forms of the metrics in these classes are derived. Of these metrics, the vacuum ones are shown to be algebraically special, in the sense of the Petrov classification. Author

N67-40494*# Colorado State Univ., Fort Collins. Dept. of Mathematics and Statistics.
BOUNDS FOR THE ZEROS OF POLYNOMIALS Final Report, 1 Apr. 1966–30 Sep. 1967
Richard J. Painter 1 Oct. 1967 14 p refs
(Grant NGR-06-002-041)
(NASA-CR-89579) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Results are derived from an application of a theorem of A. Brauer to the companion matrix of a polynomial and application of the theorem of Rouche. The pattern is in some sense a rounding out of the results derived earlier. Author

N67-40563*# Georgia Inst. of Tech., Atlanta.
ON THE DIFFERENTIAL EQUATIONS OF THE AXISYMMETRIC VIBRATION OF PARABOLOIDAL SHELLS OF REVOLUTION
James Ting-shun Wang and Chi-wan Lin Nov. 1967 22 p refs
(Grant NsG-571)
(NASA-CR-932) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The dynamic behavior of shells of revolution is discussed with respect to importance in space vehicle designs. Equations of axisymmetric motion for paraboloidal shells of revolution are derived

according to the linear bending and membrane theories. A method of procedure according to the finite difference technique for the study of the free vibration of the shell is given. S.P.

20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

N67-39403 Joint Publications Research Service, Washington, D. C.
TRANSLATIONS ON COMMUNIST CHINA: SCIENCE AND TECHNOLOGY, NUMBER 393
5 Oct. 1967 39 p Transl. into ENGLISH from Ti-Li (Peking), no. 2 and 3, Mar.–May 1965
(JPRS-42845; TT-67-33471) CFSTI: $3.00

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1. STRATOSPHERE S.-y. T'ao p 1–17 (See N67-39404 24-20)
2. TYPHOON S.-y. T'ao p 18–34 (See N67-39405 24-20)

N67-39404 Joint Publications Research Service, Washington, D. C.
STRATOSPHERE
Shin-yen T'ao *In its* Transl. on Communist China: Sci. and Technol., No. 393 5 Oct. 1967 p 1–17 (See N67-39403 24-20)

Recent discoveries are briefly reviewed, emphasizing the stratospheric circulation. The characteristics of the atmospheric layers are mentioned, along with meteorological balloons and rockets. The composition of the stratosphere is described, and the characteristics and chemical properties of ozone are indicated. The temperature, wind, and pressure fields of the stratosphere are discussed. The temperature changes and disturbances are summarized, and the interrelations between stratosphere conditions and ground surface weather are briefly studied. N.E.N.

N67-39405 Joint Publications Research Service, Washington, D. C.
TYPHOON
Shih-Yen T'ao *In its* Transl. on Communist China: Sci. and Technol., No. 393 5 Oct. 1967 p 18–34 (See N67-39403 24-20)

The structure, formation, and motion of typhoons are discussed briefly. Shape, size, temperature, and velocity characteristics are outlined, and the spatial and temporal distributions of the typhoons are indicated. Methods of forecasting them are reported, and the damaging characteristics inside are described. Suggested theories of formation and possible means of controlling typhoons are reviewed. N.E.N.

N67-39453# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
ON THE BEHAVIOR OF DERIVATIVE PROCESSES
Walter B. Miller and Henry Rachele Jun. 1967 27 p refs
(ECOM-5133; AD-657561)

Radar, and high speed photo and optical theodolites are being used more frequently by the meteorologist for obtaining wind velocity data. These systems yield position data at a much faster rate than conventional optical theodolite systems. When deriving velocity data from the basic azimuth, elevation and range data, several factors should be taken into consideration. Of the many factors considered, the most significant presented in this paper are the expression for the expected value of the position components in an XYZ Cartesian coordinate system, a discussion of the simple difference method for computing velocity, a method to test the hypothesis that the position points can be expressed as a linear function of time, the effectiveness of using a least-squares technique if the position points are a linear function of time, and the expectations of velocity and velocity variance when the position points are a polynomial function of time with certain random deviations. Author (TAB)

N67-39523# Army Tropic Test Center, Fort Clayton (Canal Zone).
ENVIRONMENTAL DATA BASE FOR REGIONAL STUDIES IN THE HUMID TROPICS Monthly Microclimatic Summary Report
Michael A. Fradel and Wilfried H. Portig Mar. 1967 30 p
(ARPA Order 740)
(AD-657597)

Monthly microclimatic data summarized in this series of reports were collected by the US Army Tropic Test Center and the Weather Engineers of Panama Corporation under the project, Environmental Data Base for Regional Studies in the Humid Tropics. The project is sponsored by the Advanced Research Projects Agency of the Department of Defense and by the Army Research Office, Office of the Chief of Research and Development. It is an investigation of microclimatic, air chemistry, vegetation, soils, microbiological, and macrofaunal conditions at selected sites in the principal tropical environments of the Panama Canal Zone and the Rio Hato Military Reservation. The objective of the project is to assemble quantitative environmental data for RDT+E purposes. Author (TAB)

N67-39583# Freie Univ., Berlin (West Germany). Institut fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXX, NO. 1: WEATHER SATELLITE OBSERVATIONS AND THEIR APPLICATIONS. THE EUROPEAN WEATHER PICTURE, PART I, MARCH–APRIL 1966 [METEOROLOGISCHE ABHANDLUNGEN. BAND LXX, HEFT I: WETTERSATELLITENBEOBACHTUNGEN UND IHRE AUSWERTUNG. DAS EUROPAEISCHE WETTERBILD 1966. TEIL I, MAERZ–APRIL 1966]
Ingrid Haupt 1966 226 p refs In GERMAN; ENGLISH summary
CFSTI: HC $3.00/MF $0.65

The present volume starts a series of publications which continuously gives the weather-satellite observations of the European-Atlantic area. It presents satellite-pictures of March and April 1966 of ESSA 2. A general introduction is given to the weather-satellite program since 1960 and supplies remarks in order to assist the users of satellite-pictures in location procedures, in identification, and in interpretation as well as remarks on the APT-system. Shown also is a daily publication of the Berlin Institute for Meteorology which contains a cloud-mosaic and a short description. The most significant orbital data of ESSA 2 for March and April 1966 is presented in list form. Author

N67-39591# Dayton Univ., Ohio. Research Inst.
REPORT ON HIGH ALTITUDE ROBIN FLIGHTS OCTOBER 1966
Nicholas A. Engler Bedford, Mass., AFCRL, May 1967 25 p refs
(Contract AF 19(628)-4796)
(AFCRL-67-0433; SR-1; AD-657810)

Tracking data from high altitude ROBIN balloon flights are reduced to yield meteorological parameters. Plots of these parameters are shown and comparison is made to a model. Different

smoothing techniques are examined using objective methods. Differences in the meteorological parameters as a function of the smoothing interval are examined. Author (TAB)

N67-39699# Florida State Univ., Tallahassee. Meteorology Dept.
THE EFFECT OF HAZE UPON UMKEHR MEASUREMENTS
John J. de Luisi 1 Jul. 1967 175 p refs
(Contract AF 19(628)-4953; Grants NSF GP-2393; NSF GA-333)
(AFCRL-67-0367; Rept.-67-3; SR-3; AD-658007)

The use of Mie-scattering functions in a primary-scattering model show that haze affects an Umkehr curve by slightly increasing the N-values for zenith angles of about 60-75 degrees, and slightly decreasing the N-values for zenith angles of about 75-90 degrees. A cross-over point is implied. Another implication derived for the model calculations is that the type and amount of variation of the Umkehr curve depends mostly on the total optical depth of haze particles and not so much on the size distribution and refractive index of the haze particles, within reasonable limits of variation. The existence of simultaneous balloon-Umkehr data, obtained at Florida State University, permits an experimental analysis of the influence of haze upon Umkehr curves. Both model and experimental results show that for a C-wavelength-pair Umkehr curve that has been normalized to zero at a zenith angle of 60 degrees, the presence of haze decreases the N-values (on the average) by a maximum value of 2 at a zenith angle of 80 degrees. From the experimental haze residual, a total average optical depth of haze particles of .30-.33 is inferred for a standard clear atmosphere over Tallahassee. Umkehr curves that have been adjusted for an average haze effect produce ozone distributions that agree better with the simultaneously measured balloon ozone distributions.
Author (TAB)

N67-39825# Air Force Cambridge Research Labs., Bedford, Mass. Aerospace Instrumentation Lab.
CLEAR LINES-OF-SIGHT FROM AIRCRAFT
Eugene A. Bertoni Aug. 1967 188 p refs *Its* AF Surv. in Geophys. No. 196
(AFCRL-67-0435; AD-657801)

An in-flight observation program to collect observations of the presence, or absence, of clear lines-of-sight at several angles in the vertical plane has been completed. Approximately 72,000 observations were collected over a period of about 15 months. Observations were taken by flight crews of the Air Force, Navy, and Pan American Airways. Data were obtained over most of the Northern Hemisphere, except the area from 30E to 110E. All observations taken within a 10 deg latitude-longitude sector were grouped together by altitude and season. The relative frequency of a clear line-of-sight is plotted in the appropriate area on maps for various lines-of-sight. The number of observations on which the relative frequency is based is shown in parentheses. The relative frequencies are intended to serve as estimates of the probabilities of clear lines-of-sight. These estimates should be considered as a first approximation since, (a) the observations were taken in a very subjective manner, (b) the estimates are based only on about one season of data, and (c) cloud variability may be quite large within some 10 degree sectors. Author (TAB)

N67-39842# Weather Wing (4th), Ent AFB, Colo. Aerospace Sciences Div.
ONSET-DURATION TABLES OF SPECIFIED CEILING AND VISIBILITY CATEGORIES
Joe S. Restivo Aug. 1967 22 p ref *Its* Tech. Paper 67-1
(AD-658038)

The paper describes a new type of table which shows for each initial ceiling (and visibility) category, frequency distributions of onset times, a duration history based on successive hours of occurrence and a complete history of the type and frequency of subsequent one-hour weather category changes. Author (TAB)

N67-39854*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
AN ATLAS OF TOTAL OUTGOING LONG-WAVE RADIATION AND OF SHORT-WAVE REFLECTANCES FROM NIMBUS II OBSERVATIONS
Musa Pasternak Oct. 1967 67 p refs
(NASA-TM-X-55974; X-622-67-500) CFSTI: HC $3.00/MF $0.65 CSCL 04B

An atlas of total outgoing long-wave radiation and of short-wave reflectances derived from measurements of the Nimbus II Medium Resolution (Infrared) Radiometer (MRIR) during its life-time from 15 May to 27 July 1966 is presented. The outgoing longwave radiation has been derived from measurements of the 5–30 micron channel whereas the short-wave reflectances have been derived from measurements of the 0.2–4.0 micron channel. Weekly averages of the data over the entire globe are presented in mapped form, utilizing Mercator and polar stereographic projections.
Author

N67-39761# Honeywell, Inc., St. Paul, Minn. Research Dept.
LOW FREQUENCY ELECTRIC FIELD CHARACTERISTICS OF CLEAR AIR TURBULENCE Final Report, 15 Mar. 1966–15 Jul. 1967
H. W. ten Broek and C. R. Seashore 15 Jul. 1967 157 p refs
(Contract AF 19(628)-5983)
(AFCRL-67-0457; Rept.-12037-FR1; AD-658875)

The report covers work done to investigate the low-frequency electric field characteristics of clear air turbulence. A description is given of the electric field sensing system designed and constructed by Honeywell and installed in five Northwest Airlines 720B passenger jets. The equipment was used to gather experimental data on the correlation of electric field activity with CAT, when encountered, during the scheduled flights of these aircraft in the period between October 1966 and June 1967 (a total flight time for all five CAT units of approximately 4300 hours). In this period, a total of 2,320 hours of recorded electric field data was obtained, during which 131 pilot-indicated encounters with CAT occurred. An investigation of the correlation of these encounters with the recorded data is presented, and the effects of various noise sources on system operation are discussed. The results of the data-taking program indicate that significant electrical activity occurred prior to and during 51.5 percent of these pilot-indicated CAT encounters exhibiting g-activity greater than plus or minus .05 g. Meteorological analyses of weather conditions in the vicinity of the encounters, useful in differentiating between the types of CAT encountered and in substantiating pilot-indicated events, could not be performed within the scope of the program. Author (TAB)

N67-39798# Air Force Cambridge Research Labs., Bedford, Mass. Meteorology Lab.
WIND AND TEMPERATURE PROFILES FROM PROJECT WINDY ACRES
Jun. 1967 163 p
(AFCRL-67-0339; AD-658827)

During an experimental program conducted in 1965 by the Boundary Layer Branch at AFCRL, data were collected in three continuous operations, each lasting approximately 12 hours. The data consist primarily of vertical profiles of wind, temperature and Richardson numbers in 15-min blocks covering periods from early evening to early morning. Author (TAB)

N67-39802 Air Weather Service, Scott AFB, Ill.
TECHNICAL EXCHANGE CONFERENCE Final Report
Jul. 1967 298 p refs Proc. held in Monterey, Calif., 4–7 Apr. 1967
(AWS-TR-196; AD-819188)

Conference papers or summaries of papers on interpretation and use of meteorological satellite data, solar and upper atmospheric

phenomena, dynamic models of the atmosphere, tropical meteorology, surface weather and boundary-layer phenomena, and data handling and prediction techniques are presented. For individual titles, see N67-39803 to N67-39828.

N67-39803 Environmental Science Services Administration, Washington, D. C. National Environmental Satellite Center.
SOME SOLUTIONS TO WEATHER ANALYSIS PROBLEMS THROUGH THE USE OF SATELLITE DATA
Edward W. Ferguson *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 1–10 refs (See N67-39802 24-20)

Large scale cloud patterns and cloud distribution as observed in satellite data identify the positions of vortices, fronts, jet streams, upper level troughs and ridges, surface ridges and centers of mid-tropospheric cyclonic vorticity. Cloud types and cloud line orientation provide information concerning the stability and thermal structure of the atmosphere. Examples of these cloud patterns are shown and related to synoptic analyses, atmospheric motions, and temperature structure. Then examples are shown on how information derived from satellite data can be applied to weather analyses and forecasts. Author

N67-39804 Air Force Technical Applications Center, Washington, D. C.
APPLICATION OF SATELLITE PICTURE INTERPRETATION PRINCIPLES TO ANALYSIS IN SPARSE DATA REGIONS
Golden R. Farr *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 11–32 refs (See N67-39802 24-20)

Analyses for surface and upper air charts were made using only features seen in the satellite cloud pictures. Rules of interpretation in use at the National Environmental Satellite Center and streamline analysis procedures were used to derive rather detailed charts for the surface, 500 mb, thickness (approximately 1000 to 500 mb), and 200 mb. It is shown that useful surface and upper air analyses for data sparse regions can be derived from the satellite cloud pictures, and that conventional analyses can be refined and improved. Author

N67-39806 Weather Wing (1st), Fuchu (Japan).
APT USE AT FUCHU AF WEATHER CENTRAL
Lee G. Dickinson *In* Air weather Serv. Tech. Exchange Conf. Jul. 1967 p 39–42 (See N67-39802 24-20)

APT use is described with particular emphasis on its value to a weather central whose area of responsibility includes large oceanic and potentially data-silent areas. The technique Fuchu developed for preparing APT pictures for facsimile transmission is outlined. Fuchu's participation in the WEFAX experiment and Japanese uses of APT are reviewed. Author

N67-39807 Environmental Science Services Administration, Washington, D. C. National Environmental Satellite Center.
RECENT RESEARCH ON THE APPLICATION OF METEOROLOGICAL SATELLITE DATA TO NUMERICAL WEATHER ANALYSIS
E. Paul McClain and Harold J. Brodrick *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 42–50 refs (See N67-39802 24-20)

Major cloud systems and the mass structure of the atmosphere are linked through the time-integrated three-dimensional air motions. One approach to the general problem of inferring the state of the atmosphere in sparse data regions from satellite information is that of synoptic/dynamic modeling. A model of the stages in the evolution of deep stratiform cloud systems associated with major extratropical cyclones has been developed in terms of the evolving vorticity and thermal structure of these systems. The four stages of development are illustrated schematically and by means of TIROS and ESSA pictures from two cases. Author

N67-39808 Allied Research Associates, Inc., Concord, Mass.
APPLICATIONS OF SATELLITE OBSERVATIONS OF EXTRATROPICAL CLOUD VORTICES
William K. Widger, Jr., C. William Rogers, and Paul E. Sherr *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 52–82 refs (See N67-39802 24-20)

The combined use of satellite television and infrared observations has provided an improved understanding of the three-dimensional cloud patterns associated with extratropical cyclones, and of the typical sequence of development of these patterns. It appears that dynamically induced vertical motions are of particular significance during the early stages of system development, and remain significant in the eastern portions of a system through at least the mature stage. Horizontal advection of existing cloud covered and clear areas becomes paramount in the western portions of these systems. These findings are being confirmed and extended by further analyses which include concurrent, multiple level, vertical motion computations. The existing findings, however, already provide an operationally applicable basis for estimating the probable stage of storm development, especially in areas deficient in conventional data. It would appear that the horizontally advected cloud cover to the west of a mature cyclonic center may be a factor in accelerating dissipation, and may ultimately need to be taken into account as diabatic effects are included in numerical prediction models. Some speculations as to the processes occurring during the initial stages of cyclo-genesis are also included. Author

N67-39812 RAND Corp., Santa Monica, Calif.
NUMERICAL SIMULATION OF CUMULUS CONVECTION
Francis W. Murray *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 121–125 refs (See N67-39802 24-20)

Atmospheric thermal convection, including condensation and evaporation, is modeled on the cumulus scale by numerically solving the equations of hydrodynamics and thermodynamics. Appropriate Boussinesq equations are derived for both axial and rectilinear symmetry. A mixed Eulerian–Lagrangian method is used. A specific example is discussed, and its computational results are compared with observations made from instrumented aircraft of the Naval Research Laboratory. It is concluded that the model is realistic in many respects, and that it could be a useful adjunct for research in cloud dynamics and cloud physics, particularly in the field of weather modification. Author

N67-39813 Weather Wing (3rd), Offutt AFB, Nebraska.
ON THE APPLICATION OF SCALING THEORY AND ENERGETICS TO THE THIRD WEATHER WING SIX-LEVEL MODEL
Harold B. Hart *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 127–132 refs (See N67-39802 24-20)

A brief review of scaling theory for middle latitude macroscale flow together with energy balance considerations is presented. The WW Six-Level Model equations are then scaled and analyzed with respect to their consistency from the point of view of scale theory and energy balance. Author

N67-39817 National Center for Atmospheric Research, Boulder, Colo.
RECENT PROGRESS ON GENERAL CIRCULATION EXPERIMENTS AT NCAR
Warren M. Washington and Akira Kasahara *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 162–171 refs (See N67-39802 24-20)

A general circulation model is described, in which the height is used as the vertical coordinate instead of the more customary pressure. Two horizontal equations of motion and the pressure tendency equation in spherical coordinates are given. An experiment

was conducted to simulate a mean January circulation, and typical daily weather patterns are shown on different map projections produced by a cathode ray tube graphic display unit. Synoptic features of the preliminary results are discussed and depicted. M.G.J.

N67-39818 Air Force Cambridge Research Labs., Bedford, Mass.
GRID TELESCOPING IN NUMERICAL WEATHER PREDICTION
Geoffrey E. Hill *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 172–177 (See N67-39802 24-20)

A method is devised whereby numerical forecasts cover the whole Northern Hemisphere, yet in certain regions the grid spacing is made as small as 40 km. The method involves solution of numerical equations on a grid of data points in the usual way. Then, results from that forecast are used for the boundary conditions of a more dense but smaller-size grid network placed within the original one. Successively smaller grids are introduced so that the final grid size is as small as desired. So far, results have been obtained from a barotropic model with a grid spacing reduced from 655 km to 82 km, and from a simple 2-level baroclinic model with a grid spacing reduced from 655 km to 164 km. Author

N67-39819 Naval Postgraduate School, Monterey, Calif. Dept. of Meteorology and Oceanography.
THE APPLICATION OF NUMERICAL ANALYSIS OF BAROCLINICITY TO THE OBJECTIVE LOCATION OF FRONTAL ZONES
Robert J. Renard *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 179–201 refs (See N67-39802 24-20)

The model used to obtain a first approximation to frontal position and strength is based on the widely held dynamic–synoptic concept of frontal zones, described in the Glossary of Meteorology, as "the three dimensional zone or layer of horizontal density gradient bounded by frontal surfaces across which the horizontal density gradient is discontinuous". Stated in another, but equivalent way, the model depicts frontal zones which are hyperbaroclinic regions whose boundaries, practically speaking, are quasi-first-order discontinuities in the thermal field. Author

N67-39823 Army Natick Labs., Mass.
THE RELATIONSHIP BETWEEN DAILY AND ANNUAL RAINFALL IN THAILAND
Ruth L. Wexler *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 226–242 refs (See N67-39802 24-20)

From daily rainfall observations in Thailand for a number of stations, the respective annual rainfall mass distributions have been determined. Preliminary results indicate that these distributions are similar to those found elsewhere. Therefore, a universal rainfall distribution curve may be employed for estimates of daily (hourly) intensities, as is demonstrated. Prediction equations and nomograms are provided. Estimates are compared with observations. The required parameters are the total amount of annual precipitation and the corresponding number of rain days per year. While the study is concerned mainly with the relationship between the daily and annual rainfall, hourly intensities are considered briefly. Author

N67-39824 Allied Research Associates, Inc., Concord, Mass.
DIURNAL STUDIES OF TIROS VII 8-12μ "WINDOW" RADIATION OVER INDONESIA AND MALAYSIA
Earl S. Merritt *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 245–253 refs (See N67-39802 24-20)
(Contract NAS5-10151)

To obtain a quantitative presentation of the diurnal TIROS VII 8 to 12μ window temperature cycle, averages were obtained from analyses composited at two-hour intervals. These averages were obtained for each island, and for selected ocean areas. The procedures followed in each case were: (1) divide the area into small subsections of approximately equal size, (2) obtain an estimate of the average TIROS VII window temperatures in each subsection, and (3) average the estimates from each subsection to obtain a mean. Additional mean values were also obtained. The results revealed a pronounced semidiurnal cloud cycle with maxima at 0600L and 1800L, and minima at 1200L and 2200L over land areas. Ocean areas revealed a similar cycle but the amplitude of the variation was much smaller than that over the land. M.G.J.

N67-39825 Environmental Science Services Administration, Silver Spring, Md. Techniques Development Lab.
SHORT RANGE, SUBSYNOPTIC SURFACE WEATHER PREDICTION
Harry R. Glahn and Dale A. Lowry *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 254–259 refs (See N67-39802 24-20)

An on-going program to develop an operating system for making objective forecasts of weather variables on a space scale of approximately 50 miles and a time scale of 1 hour up to about 18 hours is described. The system will consist of a combination of numerical (dynamic) and statistical models. Precipitation and cloudiness forecasts for the "Today" period, 7:00 A.M. to 7:00 P.M., over the eastern United States are receiving primary emphasis. Intermediate products are hourly sea level pressure forecasts valid between 7:00 A.M. and 7:00 P.M. Author

N67-39879 International Geophysical Year World Data Center A, Asheville, N. C.
METEOROLOGICAL ROCKET NETWORK FIRINGS, VOLUME IV, NO. 2 Data Report
Feb. 1967 178 p
GPO: $3.00

Wind and temperature measurements from all available rmteorological sounding rocket firings during February, 1967, are reported; along with computed values for pressure, density, and speed of sound. Local radiosonde observations nearest the time of firing are also included. L.S.

N67-39955 Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXXVIII, NO. 7: RESULTS OF THE SYNOPTIC SERVICE, JULY 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND LXXVIII, HEFT 7: ERGEBNISSE DES SYNOPTISCHEN DIENSTES IM JAHRE 1967, JULI]
Richard Scherhag et al 1967 184 p refs In GERMAN

Presented are daily weather charts for Germany, central Europe, and the Northern hemisphere for July, 1967. Climatological averages, temperatures, precipitations, and radioactivity data of July, 1967 are summarized for Berlin, Germany. Additional articles are presented which treat the following: (1) weather forecasting for July, 1967; (2) vertical profiles of precipitation in showers; (3) the U.S. IGY Station Alpha Arctic Ocean, 1957–1958; (4) analysis and hypothesis of the instability line; (5) the meridional front; (6) order of magnitude of large-scale vertical motion in the upper stratosphere; (7) meteorology in London, England; and (8) reviews of climate and the world weather situation during July, 1967. Transl. by K.W.

N67-39959 Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXXVIII, NO. 5: RESULTS OF THE SYNOPTIC SERVICE, MAY 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND LXXVIII, HEFT 5: ERGEBNISSE DES SYNOPTISCHEN DIENSTES IM JAHRE 1967, MAI]
Richard Scherhag et al 1967 180 p refs In GERMAN

This volume contains daily weather charts for Germany, central Europe, and the northern hemisphere for May, 1967. Also given are climatological means, temperatures, precipitations, and radioactivity as recorded during May and the spring of 1967 in Berlin, Germany. Separate articles are included on the following subjects: (1) the use of lasers in meteorology; (2) weather forecasting for the summer of 1967; (3) a climatological review of the spring of 1967; and (4) a review of the world weather situation during May and the spring of 1967. Transl. by K.W.

N67-39977 Universidad Nacional Autonoma de Mexico, Villa Obregon.
SEVENTEEN YEARS OF RAIN STIMULATION OPERATIONS IN THE NECAXA AND LERMA RIVER BASINS [17 ANOS DE OPERACIONES DES ESTIMULACION DE LLUVIAS EN LAS CUENCAS DE NECAXA Y LERMA]
Jul. 1967 22 p In SPANISH

The results are presented of a statistical analysis made of the data obtained from cloud seeding operations conducted in the Necaxa and Lerma river basins of Mexico over a 17 year period. The geography and orography of each of the areas, the calendar of seedings, the equipment, and the statistical methods are described. The results are presented in tabular form and discussed. Transl. by R.N.A.

N67-40000 Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXXVIII, NO. 6: RESULTS OF THE SYNOPTIC SERVICE, JUNE 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND LXXVIII, HEFT 6: ERGEBNISSE DES SYNOPTISCHEN DIENSTES IM JAHRE 1967, JUNI]
Richard Scherhag et al 1967 170 p refs In GERMAN

Daily weather charts are presented for Germany, central Europe, and the Northern Hemisphere for June, 1967. Summarized for Berlin, Germany, are climatological averages, temperatures, precipitation, and radioactivity during June, 1967. Also included in this volume are the following subjects: (1) bases for weather forecasts for the summer of 1967; (2) effects of the first Chiness H bomb test on atmospheric pressure registrations in Berlin, Germany; (3) detection of catastrophic rainfall in a weather map; and (4) tables for computing zonal and meridional components of the wind. Transl. by K.W.

N67-40018# Emmanuel Coll., Boston, Mass. Research Language Center.
AN ANALYSIS OF THE SYNOPTIC PROCESSES DURING THE EASTWARD MOVEMENT OF TROUGHS IN THE SOUTHERN BRANCH OF THE UPPER WESTERLIES ABOVE A CUSHION OF COLD AIR OVER SOUTH CHINA IN SPRING
Tsih-hsiu Hsu and Mu-wei Wang Bedford, Mass., AFCRL Jul. 1967 24 p refs Transl. into ENGLISH from Ch'i Hsiang Hsueh Pao (Peking), v. 35, no. 2, May 1965 p 117-125
(Contract AF 19(628)-5073)
(Emm-66-139; TT-67-62941; AD-658843)

After the intrusion of cold air into South China in spring a thin layer of cold air often prevails over the east of the Tibetan Plateau, forming a cushion of cold air. When zonal circulation dominates the upper troposphere, troughs over the cold cushion tend to move eastward along the southern branch of the upper westerly jet. Under such circumstances, the high pressure area at the surface tends to break up to make way for frontogenesis and the development of surface troughs. The present study deals with such synoptic processes over South China for the months of March to May during 1958 - 1962. Problems on short-range prediction of precipitation and thunderstorm activities associated with these processes are also discussed. Author (TAB)

N67-40035 Finnish Meteorological Office, Helsinki.
CLIMATOLOGICAL DATA, 1966 [ILMASTOHAVAINNOT, 1966]
1967 92 p refs *Its* Meteorol. Yearbk. of Finland, Vol. 66, Pt. Ia-1966

Daily observations from 7 stations and monthly and yearly summaries from 140 stations throughout Finland are presented in tabular form. The data include temperature, precipitation, relative humidity, ground surface condition, cloud cover, and wind direction and velocity. N.E.N.

N67-40038 Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXXVIII, NO. 4: RESULTS OF THE SYNOPTIC SERVICE, APRIL 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND LXXVIII, HEFT 4: ERGEBNISSE DES SYNOPTISCHEN DIENSTES IM JAHRE 1967, APRIL]
Richard Scherhag et al 1967 162 p ref In GERMAN

Presented are daily weather charts for Germany, central Europe, and the Northern Hemisphere for April, 1967. Summaries are given for Berlin, Germany, on climatological averages, temperatures, precipitation, and radioactivity during April, 1967. Additionally included in this volume are the following subjects: (1) review of the world weather situation of April, 1967; (2) precipitation in Berlin, Germany, during the water budget year 1966; (3) air traffic and clear-air turbulences; and (4) aircraft accident over Cyprus and the tornado in Chicago during April, 1967. Transl. by K.W.

N67-40100# Freie Univ., Berlin (West Germany). Institut fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXXI, NO. 4: INFLUENCE OF THE MOON ON THE WEATHER PICTURE [METEOROLOGISCHE ABHANDLUNGEN. BAND LXXI, HEFT 4: DER EINFLUSS DES MONDES AUF DIE WITTERUNG]
Horst Dronia 1967 92 p refs In GERMAN; ENGLISH summary
CFSTI: $3.00

A review of research on the problem of the moon's influence on the weather is presented. The daily and monthly effect of the moon on the atmosphere above the tropopause is considered as certain and increases with height. Influences on the 500 mb level temperature seem to exist in the order of magnitude of some tenths centigrade. In regard to the atmospheric pressure, an effect of the synodical revolution is most probable. The best agreement is found for undernormal pressure at new and full moon about 1 to 2 mb. For the precipitation a certain influence can be affirmed. In addition to probable indications of dependence on the moon's distance and declination convincing research has been made showing a relation to the phases of the moon. It shows amplitudes of about 5 to 15% of the average. Increasing sunspot activity seems to enlarge the effect. Author

N67-40101 Finnish Meteorological Office, Helsinki.
OBSERVATIONS OF RADIOACTIVITY, 1966
1967 68 p ref *Its* Observations of Radioactivity No. 6

Fractions of aerosol beta-activity that decay within 4 hours and those that remain three days after the end of a sampling

period are considered. Measurements of beta-activity in precipitation and settled dust are also included. Hourly values of the aerosol beta activity decaying within four hours after the sampling period are presented for each of the eight sampling localities. The mean diurnal variation of short-lived aerosol beta activity is illustrated. S.P.

N67-40241# Weather Squadron (12), Suffolk County AFB, N. Y., Detachment 9

AN INVESTIGATION OF LOW VISIBILITY DURING JANUARY AND FEBRUARY AT SUFFOLK COUNTY AIR FORCE BASE

Sydney M. Cohen 12 Jun. 1967 22 p
(AD-658889)

The investigation of conditions leading to low visibility at Suffolk County AFB (FOK) during January and February was approached in four ways. This paper defines deterioration as a decrease in visibility to four miles or less. Likewise, low visibility is a visibility of four miles or less. The first approach was accomplished by graphically plotting the dew point depression as a function of cloud cover at sunset. The only conclusion was that when the depression is 8F or less, regardless of cloud cover, the probability for low visibility in the next several hours is 80.7%. The second approach involved an analysis of cloud cover as a function of dew point depression for both six and three hours prior to the recorded low visibility. For the same times an analysis was also made of wind direction vs. dew point depressions. The final approach was a study of the relationship between low visibility and the preceeding local pressure changes. Author (TAB)

N67-40307# Emmanuel Coll., Boston, Mass. Research Language Center.

A STUDY OF THE THERMAL LOW OVER SOUTHWEST CHINA AND RELATED FORECASTING PROBLEMS

Guo-wen Li Bedford, Mass., AFCRL, Jul. 1967 19 p Transl. into ENGLISH from Ch'i Hsiang Hsueh Pao (Peking), v. 35, no. 2, May 1965 p 126–131
(Contract AF 19(628)-5073)
(Emm-66-141; TT-67-62942; AD-658844)

The thermal low which develops near the Szechwan basin is an important synoptic system exerting a pronounced influence on the weather over Southwest China in spring. The affected region is characterized by high temperatures, low humidity, fine weather with good visibility and a marked intensification of southerly winds. In addition, strong southerlies often prevail over western Kweichow and northern Yunnan. The dissipation of this type of thermal low usually brings precipitation and a fall of air temperature in the Szechwan-Kweichow region. The present study reveals the relationship between the thermal low and the upper vortex which appears at the 700-mb level over Southwest China above the thermal low prior to its maximum development. However, about 24-36 hours after its birth the 700-mb vortex usually moves eastward under the influence of a 500-mb trough in the upper westerlies, and the surface thermal low then begins to fill up. This paper summarizes the empirical rules governing the formation and development of the thermal low. Empirical predictors to forecast the growth and dissipation of the thermal low are derived from changes of meteorological elements at Kweiyang as plotted on synoptic charts. Author (TAB)

N67-40441 Freie Univ., Berlin (West Germany). Institut fuer Meteorologie und Geophysik.

METEOROLOGICAL DATA. VOLUME LXXVI, NO. 3: RESULTS OF THE RADIOSONDE STATION BERLIN-TEMPELHOF ASCENTS OF THE INSTITUT FUER METEOROLOGIE UND GEOPHYSIK OF THE FREIE UNIVERSITAET BERLIN, MAY 1966 [METEOROLOGISCHE ABHANDLUNGEN, BAND LXXVI, NO. 3: ERGEBNISSE DER AUFSTIEGE DER RADIOSONDENSTATION BERLIN-TEMPELHOF DES INSTITUTS FUER METEOROLOGIE UND GEOPHYSIK DER FREIEN UNIVERSITAET BERLIN IM JAHRE 1967, MAERZ]

Richard Scherhag et al 1967 92 p refs In GERMAN; ENGLISH summary

The detailed results of the radiosonde ascents performed by the aerological station Berlin are presented. Extreme and mean values of the temperature, geopotential, pressure, wind data, refractivity, density, pseudopotential temperature and velocity of sound for all standard pressure surfaces and for several height levels, the tropopause and the freezing level were extracted. Author

N67-40506 General Electric Co., Philadelphia, Pa. Missile and Space Div.

INFLOW LAYER IN A MATURE HURRICANE

A. Barcilon Oct. 1967 38 p refs
(R67SD59)

A self-consistent expression is derived for the angular momentum distribution above the inflow layer and the flow field in that layer is solved. A nearly neutral atmosphere is assumed and modelled in a rotating annulus bounded by two horizontal surfaces. The vertical outer wall models the temperature characteristics of the tropical atmosphere while the inner wall models those of moist adiabatic ascent. A linear small Rossby number flow is first considered and the zero net mass flux requirement across any vertical cylinder leads, after considering inviscid and Ekman layer flows, to a differential equation for the distribution of angular momentum. Such a model serves as a guide to extend the analysis to the nonlinear high Rossby number flow. Author

N67-40514# Dayton Univ., Ohio. Research Inst.

A DIGITAL AIRBORNE METEOROLOGICAL DATA COLLECTION SYSTEM

Donald A. Kahle Jun. 1967 54 p refs
(Contract F19628-67-C-0101)
(UDRI-TR-67-128; SR-1; AFCRL-67-0420; AD-658865)

The report presents the results of a study of data collection means for an airborne meteorological data collection project conducted by the meteorology laboratory of the Air Force Cambridge Research Laboratories. Recording media, recording techniques, automation of data processing, time required for processing, and cost of the final data are some of the considerations investigated in the study. To fulfill the particular requirement that prompted this study, a digital magnetic tape recording system is proposed and described in detail. Author (TAB)

21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

N67-39537# RAND Corp., Santa Monica, Calif.

ERROR SENSITIVITY ASSOCIATED WITH ORBITAL HYPERBOLIC-NAVIGATION SCHEMES AND A SUGGESTED APPROACH FOR IMPROVEMENT

J. H. Hutcheson Jul. 1967 40 p refs Presented at the AGARD Symp. on Advan. Navigational Tech., Milan, 12–15 Sep. 1967
(P-3636; AD-657751)

This paper deals with the fundamental mathematical relationships applicable to satellite-linked hyperbolic systems in general (i.e., direct or inverse, the direction of the propagation paths being insignificant). Error expressions are developed for determining the sensitivity of a system to uncertainties in measurement and to satellite geometry. A LORAN satellite system involves obtaining lines of position from the intersection of hyperboloids of revolution with a spherical earth. The resultant

second-order equations are solved by a computer using iterative techniques. Solutions in the form of error sensitivities are presented for a number of vehicle-satellite geometric configurations. A particular problem arises when the receiving stations and the propagating sources are located in certain geometrical configurations. Results are presented from the standpoint of navigators lines of position (LOPs) intersecting at unfavorable angles that can cause the sensitivity to error to become unbounded. The problem becomes more complicated if satellite relative motion is involved because the orientation of the LOPs will change as a function of time. However, results indicate that certain general statements can be made regarding the number of satellites needed and the configurations necessary to meet a specified set of operational requirements. It is pointed out that known satellite velocity information is not being exploited in range only or hyperbolic satellite systems, and it is recommended that further study be directed to the area of the multisatellite, multielement fix-determination processing using range-rate doppler data. Author (TAB)

N67-39703# Bunker-Ramo Corp., Canoga Park, Calif.
ALL WEATHER LANDING SIMULATION FOR CATEGORY III AIRBORNE CONFIGURATION. VOLUME I: SUMMARY OF STUDIES ON FLIGHT DIRECTORS AND SPLIT AXIS CONTROL Final Report
C. A. Gainer, R. D. Monroe, J. E. Brown, C. M. Bertone, D. W. Nichols et al Jul. 1967 114 p ref
(Contract FA-64-WA-5143)
(SRDS-RD-67-56, Vol. I)

Two flight simulation studies were completed testing the feasibility of current display-control concepts and hardware for commercial subsonic jet transport all-weather approach and landing. It was concluded that current flight director displays require modification for improved flare and decrab information. Lateral control problems were the greatest single cause of unsuccessful touchdowns; an improved decrab presentation only slightly improved performance. The introduction of display and control failures during approach has a detrimental effect on performance at touchdown. While actively engaged on manual vehicle control, pilots overlooked many display failures, and, on some approaches where two successive display failures were given, a large number of pilots did not detect the second failure. It was demonstrated that the use of autothrottle and split axis control reduces workload and improves approach and landing performance. Author

N67-39745# Federal Aviation Agency, Atlantic City, N. J. Test and Evaluation Div.
ATC CONCEPTS FOR SUPERSONIC VEHICLES, PART II-1 Interim Report
Andrew L. Sluka Aug. 1967 71 p refs
(RD-67-38; AD-658166)

The simulation study investigated domestic and oceanic SST operations to and from John F. Kennedy International Airport in a simulated alpha numeric system representing a 1970 ATC environment. The study experimented with ATC aiding SSTs to place acceleration overpressure in sterile or sparsely populated areas, transitioning SSTs to and from parallel one-way track systems above FL 430 and the use of alpha numerics and flight path projection. Results showed that alpha numerics and flight path projection will aid in controlling supersonic operations. More expeditious ATC handling for the SST is possible by the provision of parallel one-way routes whereas the assignment of the same routes to opposite direction SST traffic is undesirable. Author (TAB)

N67-40054# European Space Data Centre, Darmstadt (West Germany).
SOME REMARKS ON THE ATTITUDE OF QUASI-SYMMETRIC ROCKETS
H. Kummer Paris, ESRO, Jul. 1967 30 p
(ESRO-TM-91) CFSTI: HC$3.00/MF$0.65

The most important theorems governing the attitude of a rolling symmetric rocket will be derived and compiled. This basis is used when handling the movement of slightly non-symmetric (called quasi-symmetric) rockets. It is shown how to describe accurately enough the attitude of a quasi-symmetric rocket by means of trigonometric functions. Estimations of the error will be performed. Author (ESRO)

N67-40200# United Research, Inc., Cambridge, Mass.
A METHOD FOR DETERMINING THE ECONOMIC VALUE OF AIR TRAFFIC CONTROL IMPROVEMENTS AND APPLICATION TO ALL-WEATHER LANDING SYSTEMS VOLUME II: TECHNICAL NOTES
[1967] 116 p refs
(Contract FAA/BRD-17)
(AD-658215)

Contents: Evaluation of benefits in dollar terms: the economic theory; Estimating the demand for commercial air transport; The effects of price and reliability on demand; Determination of cost effects of improvements; Analysis of probability of avoiding aviation accidents; Methods of estimating the physical gain from new airway and airport facilities; Results of the analysis of delay, diversion, and cancellation; Dollar benefits from all-weather landing system installations; Methods of multivariate regression; Weather at the sample airports during 1957; Sources of data - demand analysis. TAB

N67-40238# United Research, Inc., Cambridge, Mass.
A METHOD FOR DETERMINING THE ECONOMIC VALUE OF AIR TRAFFIC CONTROL IMPROVEMENTS AND APPLICATION TO ALL-WEATHER LANDING SYSTEMS, VOLUME I
[1967] 27 p
(Contract FAA/BRD-17)
(AD-658214)

The method as applied to an all-weather landing system concludes the following: Additional demand leading to increased revenues to air carriers, $11,500,000; cost savings to air carriers, $9,379,000; cost savings to general aviation, $292,000; value of accidents prevented, $3,791,000. Since the annual operating costs of an all-weather landing system were not available, the annual net return of this ATC improvement was not calculated. A further conclusion based upon a detailed study of the installation of all-weather landing systems at 22 airports (a stratified sample of all approach control airports in the United States) shows that: 50% of the total dollar benefits would be realized if installations were made at only 14 airports. Author (TAB)

22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

N67-39575 Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
LIFE EFFECTS ON THE PERFORMANCE OF CERAMIC FAST BREEDERS
A. Gandini, M. Leo, and M. Salvatores 1967 17 p refs
(RT/FI(67)23-PRV-r(67)1)

The dynamic behavior of fast breeding ceramic reactors was assessed to evaluate the dependance from the burnup of the most relevant integral parameters, in particular the sodium void coefficient, the Doppler effect, and the prompt neutron lifetime. Two reference reactors, representing a cylindrical carbide reactor assimilated to a sphere and an oxide pancake reactor assimilated to a slab geometry, were used in the analysis. The calculations were made using computational codes adopting conventional multigroup diffusion methods and generalized perturbation techniques. The results are tabulated and discussed. R.N.A.

N67-39622# Atomics International, Canoga Park, Calif.
DYNAMIC MASS TRANSFER OF STAINLESS STEEL IN SODIUM UNDER HIGH-HEAT-FLUX CONDITIONS
J. Hopenfeld and D. Darley 15 Jul. 1967 54 p refs
(Contract AT(04-3)-701)
(NAA-SR-12447) CFSTI: HC $3.00/MF $0.65

Equations governing the corrosion rate of fuel cladding material in Na cooled reactors are presented. Using corrosion data obtained from various loop tests, attempts were made to evaluate the mass transfer coefficients which appear in the basic equations. It was found that avilable loop data are inadequate to provide the needed information, mainly because the local bulk liquid concentration of the corrosion products cannot be determined to any degree of certainty in these loops. A test loop facility is described where this difficulty is eliminated by setting up concentration gradients between the suface and the bulk liquid by means of high-heat-flux heaters. Preliminary data are presented on the corrosion behavior of type 304 stainless steel exposed to 1200°F Na, with a 1250°F surface temperature. The results obtained demonstrate the feasibility of using the present method to study mass transfer mechanisms in Na. Author (NSA)

N67-39682# Argonne National Lab., Ill.
CURIUM-250 PRODUCTION IN A HIGH-FLUX REACTOR
H. Diamond, C. M. Stevens, D. N. Metta, J. L. Lerner, and F. R. Kelly May 1967 6 p refs
(Contract W-31-109-ENG-38)
(ANL-7330) CFSTI: HC $3.00/MF $0.65

Curium-250 was observed in a neutron bombardment whose nvt was $\approx 4 \times 10^{22}$ n/cm^2. It is shown that the principal source of ^{250}Cm in high-flux reactors is neutron capture by ^{249}Cm. The ^{249}Cm capture cross section is estimated from the available information. Author

N67-39720# Atomics International, Canoga Park, Calif.
HEAVY WATER ORGANIC COOLED REACTOR. SCREENING TESTS OF HYDROGEN DIFFUSION BARRIERS FOR ZIRCONIUM
W. R. Kerr 15 Aug. 1967 34 p refs Prepared jointly with Combust. Eng., Inc.
(Contract AT(38-1)-430)
(AI-CE-27) CFSTI: $3.00

Screening tests in gaseous H_2 were conducted at 399°C (750°F) to determine the efficacy of hydrogen barrier coatings for Zr alloys for use in Heavy Water Organic Cooled Reactor (HWOCR) organic coolant. Plasma-sprayed Al coatings were extremely porous and hence ineffective. ZrO_2, ZrN, and diffused Al coatings were effective H_2 barriers but subject to progressive, catastrophic failure because of their inherent brittleness. It was concluded that further investigation should consider primarily a ductile coating, such as pure Al, or coatings that can be continuously repaired in service, such as oxide coatings. Author (NSA)

N67-39721# Atomic Energy Commission Research Establishment, Lucas Heights (Australia).
ECONOMICS OF THE H.T.G.C.R. FUEL CYCLE. PART I: PRE-DESIGN COST STUDY OF FUEL CYCLE FACILITY
J. R. May and J. M. Devine May 1967 54 p refs
(AAEC/E175, Pt. 1) CFSTI: $3.00

A conceptual design study of a facility to recycle fuel from a beryllium oxide moderated high temperature gas cooled pebble bed reactor has been made. For a facility to handle 300 kg of fuel per day, the capital cost is estimated as $A30 millions and the annual direct operating cost, excluding capital charges, as $A3.1 millions. Author

N67-39867# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
PROPERTIES OF THULIUM METAL AND OXIDE
P. Kent Smith, James R. Keski, and Carl L. Angerman Jun. 1967 40 p refs
(Contract AT(07-2)-1)
(DP-1114) CFSTI: HC $3.00/MF $0.65

Properties of thulium metal and thulium oxide were surveyed to establish specifications for reactor target materials for experimental production of ^{170}Tm for isotopic power source applications. Radiation characteristics and chemical, thermophysical, and mechanical properties are presented that are pertinent to the use of activated targets without reprocessing after irradiation. Author

N67-39859# Atomics International, Canoga Park, Calif.
HEAVY WATER ORGANIC COOLED REACTOR. SURFACE FINISH IMPROVEMENT IN CAST UC SLUGS
S. Strausberg, N. H. Katz, and H. J. Wolfe 15 Aug. 1967 75 p refs Prepared jointly with Combust. Eng., Inc.
(Contract AT(38-1)-430)
(AI-CE-48) CFSTI: HC $3.00/MF $0.65

Preliminary studies were conducted to develop an economical process for preparing UC fuel slugs as specified for HWOCR requirements. The principal deterrents to the use of as-cast slugs were: surface defects, including "cold shuts" and exterior protuberances, and excess "bow" (nonstraightness). Techniques were investigated for improving the surface of as-cast slugs, either through modifications in the melting and casting operation or through machine-finishing operations. Melting and casting studies showed that UC slug surfaces are improved by: using outgassed molds (≈2300°C), casting into preheated molds (≈1000°C), casting with the melt at slight superheat, and casting with a reduced header (riser) thickness, which reduces slug bowing. Centerless grinding techniques were adapted to provide economical surface finishing of cast UC slugs with: dimensions and OD roundness controlled to ±0.0005 in., total indicator reading (TIR) straightness controlled to 0.001 in., and surface finishes of <200μin. Author (NSA)

N67-39860# Mound Lab., Miamisburg, Ohio.
REACTOR FUELS AND MATERIALS DEVELOPMENT PLUTONIUM RESEARCH, APRIL–SEPTEMBER, 1966
28 Jul. 1967 32 p refs
(Contract AT(33-1)-GEN-53)
(MLM-1347) CFSTI: HC $3.00/MF $0.65

Phase equilibria in the ternary system in the range Pu–PuFe–PuMn were investigated. The principal characteristics of this system were found to be a complete series of solid solutions between the binary compounds, PuMn and $PuFe_2$, with a minimum solidus temperature located near PuMn, and a eutectic type valley extending across the diagram from the Pu–Mn binary eutectic at 520°C to the Pu–Fe eutectic at 413°C. The internal friction of all the allotropes of Pu was measured from 25 to 575°C by a torsion pendulum technique. The internal friction increased from 0.0007 to 0.2 over this temperature range. A considerable difference was

noted in the internal friction of the β, γ, and δ phases depending on whether the sample was being heated or cooled. The heat capacities of all of the allotropes of Pu, including the liquid, were measured from 60 to 731°C with electrorefined metal. The first valid measurement for the δ phase, 8.50 cal/g-atom-°C, was reported. Measurements in the differential calorimeter indicated that the $\gamma \rightarrow \delta$ transformation consumed 169 cal/g-atom, but only 89 cal/g-atom were released during the subsequent $\delta \rightarrow \gamma$ transformation. Further cycling between the γ and δ phases had no effect on the heat of the $\gamma \rightarrow \delta$ transformation, but the heat of the $\delta \rightarrow \gamma$ transformation continuously decreased. The liquid densities of the Pu alloys containing 5.5, 10.8, and 22.4 at. % U, respectively, were measured from near their liquidus temperatures to 870°C. These experimentally determined density values were approximately 1% larger than the calculated values based on ideal solutions of Pu and U. The viscosities of liquid Pu alloys containing 5.5, 10.8, 16.6, and 22.4 at. % U were determined from their liquidus temperatures to over 800°C. The viscosity reached a maximum value of 10.1 centipoise at the liquidus temperature of 621°C for the alloy with 10.8 at. % U. This alloy is located near the minimum liquidus temperature in this binary system.
Author (NSA)

N67-39899# Atomics International, Canoga Park, Calif.
HEAVY WATER ORGANIC COOLED REACTOR. DEVELOPMENT OF SAP-STEEL PRESSURE TUBE TRANSITION JOINTS FOR THE HWOCR
E. C. Supan 15 Aug. 1967 52 p refs
(Contract AT(38-1)-430)
(AI-CE-46) CFSTI: HC $3.00/MF $0.65

The Heavy Water Organic Cooled Reactor (HWOCR) requires a transition joint between the SAP in-core pressure tube and the out-of-core carbon steel piping. A process is described for hot press diffusion bonding of the SAP to Type 347 stainless steel; the carbon steel pipe is subsequently welded to the stainless steel. A thin layer of W is employed at the transition joint interface to prevent the formation of intermetallic compounds by diffusion during reactor service. The joint geometry and bonding parameters were optimized to provide consistently helium leaktight joints having an efficiency of 75 to 85% at 750°F relative to the tensile strength of SAP tubes. Evaluation of joints included tensile tests, thermal cycling, thermal soaking, and metallographic examination. An organic loop test section assembly was fabricated by flash welding transition joints to a SAP pressure tube. Author (NSA)

N67-39926# Atomics International, Canoga Park, Calif.
EVALUATION OF SNAP REACTOR DISPOSAL TECHNIQUES
D. K. Nelson and R. L. Detterman 30 Jun. 1967 76 p refs
(Contract AT(04-3)-701)
(NAA-SR-12433) CFSTI: HC $3.00/MF $0.65

Active and passive reactor disposal modes have been evaluated to establish their relative merits and conditions of best application for the SNAP reactor. The active disposal modes included deorbit for ocean disposal, intact earth impact and recovery, orbit enhancement, and earth escape. Random reentry was also considered as a disposal mode in the event of active disposal failure and as a primary passive mode. Author (NSA)

N67-39938 Applicazioni e Richerche Scientifiche, Milan (Italy).
CRITICAL STUDIES ON STEADY BURNOUT. PART I: CORRELATION FOR NONUNIFORM HEATING. PART II: STUDIES ON LINEAR CORRELATIONS Final Report
G. C. Clerici, S. Garriba, R. Sala, and A. Tozzi Brussels, EURATOM, Jul. 1967 144 p refs
(Contract EURATOM-073-65-11 TEEI)
(EURAEC-1833; EUR-3356.e)

The most important burnout correlations are listed for uneven axial power distribution on simple geometry channels, both in their original form and in a reduced standard form, such as $\Phi_o = \Phi_o (X_o)$. Φ_o is the burnout critical heat flux and X_o the outlet burnout steam quality. The most important correlations can be reduced to the linear form $\Phi = a\,(b - X_o)$ by means of suitable transformations and approximations. A first linearized correlation is compared to the 1830 data points, on which the Becker correlation is based. In order to eliminate certain systematic errors two new linear correlations were established and tested against 2001 data points from various laboratories. Author

N67-39939 Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
SUPPLEMENTS TO PARAMETRIC STUDIES ON NATURAL WATER REACTORS—THERMALIZATION OF NEUTRONS IN A NATURAL-WATER REACTOR AND COELACANTH CODE [COMPLEMENTS AUX ETUDES PARAMETRIQUES DES REACTEURS A EAU NATURELLE—THERMALISATION DES NEUTRONS DANS UN REACTEUR A EAU NATURELLE ET CODE COELACANTHE]
A. Elkouby and J. Mahe Brussels, EURATOM, Sep. 1967 122 p refs In FRENCH; ENGLISH summary
(Contract EURATOM-053-64-12 TEEF)
(EUR-3610.f)

The general form of the thermalization using a differential model is reviewed, and equations are developed explicitly in a heterogeneous cell with cladding. For this treatment a determination is used of the disadvantage factor with the collision probabilities in the three media making up the cell. The solution makes it possible to obtain the neutron spectrum in the fuel and consequently to calculate the cross sections for the different isotopes. Ignoring leaks, different thermalization models are compared, using the Thermos code. The fuel burn-up was calculated by means, firstly, of a multigroup method and, secondly, of a code using the secondary model for the two types of steel and Zircaloy cladding. A brief comparison was made with the partial experimental results for the Yankee core at 8400 MWd/t. Lastly, a method is described for calculating the spectrum and effective cross sections in the case of a spectral shift by a mixture of H_2O and D_2O moderator.
Author

N67-40002 Atomic Energy of Canada, Ltd., Chalk River (Ontario). General Chemistry Branch.
THE DETERMINATION OF OXIDES OF NITROGEN IN REACTOR LOOP COVER GAS
A. S. Denovan and R. W. Ashley Sep. 1967 13 p refs
(AECL-2770)

Oxides of nitrogen, in reactor loop cover gas consisting of CO_2 with up to 2% air, can be quantitatively collected using selective absorbers and then determined by gas chromatography. Statistical evaluation of the data used to obtain calibration curves gave standard deviations of ± 3.2 μg for NO, ± 2.6 μg for NO_2 and ± 5.5 μg for N_2O over the range of 15–150μg. Limits of detection for the 3 gases are: NO, 200 ppb; NO_2, 60 ppb; and N_2O, 200 ppb. Author

N67-40103*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PERFORMANCE POTENTIAL OF A RADIANT-HEAT-TRANSFER LIQUID-CORE NUCLEAR ROCKET ENGINE
Robert G. Ragsdale Washington, NASA, Oct. 1967 26 p refs
(NASA-TN-D-4148) CFSTI: HC $3.00/MF $0.65 CSCL 21F

Parametric calculations were conducted to establish the kind of performance available from a liquid-core nuclear rocket engine. The heat source is a liquid carbide containing uranium. Rotating the tube holds the molten fuel in place on inner surface

of the tube. The hydrogen gas flows axially down the tube and is heated by thermal radiation. The Reynolds number is between 26,000 and 121,000 for all cases calculated; therefore, the flow is turbulent. Mass transfer of the carbide solvent and the uranium into the flowing hydrogen occurs because of the relatively high vapor pressure of the liquid carbide mixture. The tube length was 5 feet (1.524 m) for all calculations. Engine performance is expressed in terms of specific impulse, thrust-to-core weight ratio, and hydrogen-to-uranium flow rate ratio. The calculations indicate that this liquid-core engine is potentially capable of producing a maximum specific impulse of 1660 seconds. The thrust-to-core weight ratio can be as high as 19. The hydrogen- to-uranium flow rate ratio will not exceed 100, unless the surface temperature is less than 9000°R (5000°K). The upper limits of these three parameters cannot be obtained together. One of two of them can be maximized at the expense of the other one or two. A compromise, or average, engine has a specific impulse of 1400 seconds, a thrust-to-core weight ratio of 4, and a hydrogen-to-uranium flow rate ratio of 50. Author

N67-40246# General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science.

DEVELOPMENTAL COMPONENTS FOR THE ADVANCED CONVERTER EVALUATION: REFERENCE DESIGN

S. Jaye, D. Morse, F. Bell, and S. Donelson 9 Mar. 1967 19 p refs

(Contract AT(04-3)-167)

(GAMD-7867) CFSTI: HC$3.00/MF$0.65

An evaluation of advanced converter reactors is given. A comparison of two approaches to a scale-up to 1000 MWe of the Fort St. Vrain Nuclear Generation Station is presented. The steam cycle, PCRV (prestressed concrete reactor vessel), steam generators, and refueling machine are discussed in detail. The steam generator design parameters for both designs (radial flow and axial flow) are tabulated. NSA

N67-40266*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

DETERMINATION OF REACTIVITIES USING PULSED NEUTRON TECHNIQUES FOR HIGHLY SUBCRITICAL SOLUTION REACTORS

Daniel Fieno, Thomas A. Fox, Robert A. Mueller, and C. Hubbard Ford Washington, NASA, 1967 16 p refs Presented at the Winter Meeting of the Am. Nucl. Soc., Chicago, 5–9 Nov. 1967

(NASA-TM-X-52369) CFSTI: HC$3.00/MF$0.65 CSCL 18L

Zero power solution reactors were used to perform pulsed neutron experiments and make corresponding calculations for systems ranging from critical to highly subcritical. Reactivities were determined using the so-called "area" methods and compared with absolute criticality calculations for a large range of shutdown reactivities. In addition, a method for determining subcritical reactivities from the measured prompt fundamental mode decay constants of a subcritical and corresponding delayed critical system was applied. A schematic is drawn to illustrate the solution reactor used for the experiments, and reactivity determinations are tabulated. Results demonstrated that calculated values of the prompt fundamental mode decay constants agree with experimentally determined values. The area method of Sjostrand agreed reasonably well with the calculated values over the entire range. All of the area methods were sensitive to an accurate experimental determination of the equilibrium delayed neutron background. Area methods of Garelis–Russell and Gozani both predicted reactivities that were consistently higher by 10 to 20 percent than the calculated values and were in agreement with each other. The method of Simmons and King gave values for the reactivity considerably lower than the calculated values over most of the range of solution heights. S.P.

N67-40324# Ente Nazionale per l'Energia Elettrica (Enel), Latina (Italy).

RESULTS OF THE ENQUIRY INTO THE PROSPECTS FOR THE USE OF PLUTONIUM IN ENEL WATER REACTORS [RISULTATI DELLO STUDIO RELATIVO ALLE PROSPETTIVE DI UTILIZZAZIONE DEL PLUTONIO NEI REATTORI AD ACQUA DELL'ENEL]

A. Ariemma, U. Belelli, G. Lasnoni, I. Rosa, L. Sani et al Brussels, EURATOM, Jul. 1967 235 p In ITALIAN; ENGLISH summary

(Contract EURATOM-092-66-6 TEEI)

(EUR-3478.I) CFSTI: $3.00

ENEL has begun a program on the prospects for using plutonium in thermal reactors; it will be based on experimental studies in one of their own water reactors, namely, either the Garigliano 160 MWe BWR reactor or the 300 MWe Trino Vercellese PWR reactor. This paper contains the results of the physical, economic and safety studies made in order to act as a guide for the ENEL in choosing the reactor on which to concentrate subsequent studies and perform tests with a view to the use of plutonium in regular reloads after 1971–1972. Author

N67-40356# Atomic Energy Commission Research Establishment, Lucas Heights (Australia).

VELOCITY DISTRIBUTION AND PRESSURE LOSSES FOR RANDOMLY PACKED BEDS OF SPHERES

J. Price Jun. 1967 29 p refs

(AAEC/E178) CFSTI: HC$3.00/MF$0.65

Measurements were made of fluid velocity distributions for a number of randomly packed beds of spheres using a flow separator between the exit face of the bed and the plane of measurement. The results for right cylindrical beds show that the departures from uniformity were small, except for a region within one half sphere diameter from the walls of the containing vessel where a marked increase in velocity occurred. The distribution was found to be independent of Reynolds number ($1470 < N_R < 4350$) and bed length ($9 < L/d < 36$). It was only slightly affected by the method of loading the bed, the density and tolerance of the spheres, and sphere diameter ($12 < D/d < 48$). A marked change was found for a bed which was peaked at exit. Measurements of the pressure losses across the beds were also made. The resulting friction factors for the right cylindrical beds were correlated using the general pressure loss correlation in its normal form and also in a modified form which took the measured velocity distributions into consideration. Both catered adequately for different packing methods and sphere diameter, but not for different bed lengths. Results are presented for the additional pressure losses caused by a peak at exit. Author

N67-40359# Atomic Energy of Canada, Ltd., Chalk River (Ontario).

REPLICA ELECTRON MICROSCOPY OF IRRADIATED URANIUM CARBIDE FUEL FROM PHASE 1 OF THE X-721 EXPERIMENT

A. M. Ross and D. H. Rose Aug. 1967 68 p refs

(AECL-2701) CFSTI: HC$3.00/MF$0.65

Details are given of an examination of fracture surfaces by replica electron microscopy applied to four irradiated uranium carbide specimens. These were obtained by ultrasonic drilling from known locations in two UC fuel pellets irradiated to average burn-ups of approximately 5600 and 7600 MWd/tonne U in the Chalk River NRX reactor during Phase 1 of the X-721 experiment. Numerous pores and second-phase inclusions were evident on inspection of both intragranular and intergranular surfaces. It was concluded that most of the pores were fission gas bubbles and the inclusions uranium or a uranium/fission product phase precipitated in the slightly hypostoichiometric fuel pellets during irradiation. Author

N67-40410 Atomic Weapons Research Establishment, Aldermaston (England).
PROMPT NEUTRON EMISSION FROM U-235 FISSION FRAGMENTS
E. E. Maslin, A. L. Rodgers, and W. G. F. Core Jun. 1967 35 p refs
(AWRE-O-43/67) CFSTI: 5s

A description is given of measurements of the prompt neutron emission from fission fragments of U-235 in thermal neutron induced fission. A beam of neutrons from the AWRE research reactor Herald induces fissions in a thin (20 $\mu g/cm^2$) sample of U-235. Neutrons are detected in a large (250 litres) liquid scintillation counter and the fragment kinetic energies are measured with gold–silicon surface barrier counters. Distributions, showing the neutron emission from both individual fission fragments and from pairs of fragments, are given as functions of both the mass of the fragment and the total kinetic energy of the pair. Author

N67-40454# Societa Ricerche Impianti Nucleari, Saluggia (Italy).
INVESTIGATIONS FOR THE CALCULATION OF THE FISSION-PRODUCT RELEASE FROM IRRADIATED FUEL ELEMENTS WITH A VIEW TO THE TRANSPORT THEREOF, PART I [INVESTIGATIONS POUR LE CALCUL DU RELACHEMENT DE PRODUITS DE FISSION DES ELEMENTS COMBUSTIBLES IRRADIES EN VUE DE LEUR TRANSPORT, PARTIE I]
R. Crostini and A. Rossi Brussels, EURATOM, Sep. 1967 70 p refs In FRENCH; ENGLISH summary
(Contract EURATOM-032-66-1 EC11)
(EUR-3623.f) CFSTI: HC $3.00/MF $0.65

The final report consists of nine parts, published separately. This volume, Part I, comprises: (1) an account of the origin of the present study, which takes into account the IAEA regulation on the transportation of irradiated fissile materials; (2) a summary of the steps which led up to the work programme (bibliographical analysis of the properties of fissile and cladding materials, test calculations of fission product release under normal transportation conditions and after a thermal accident during transportation); (3) a relatively detailed summary of Parts II–IX, illustrating and explaining each in the light of its practical aims and showing the existing gaps and uncertainties; (4) a general analysis of measures which would fill in some of the gaps in question; and (5) proposals for concrete research on the release of fission products by irradiated fuel elements. Author

N67-40455# Centre d'Etude de l'Energie Nucleaire, Mol (Belgium).
DEVELOPMENT AND IN-PILE PERFORMANCE OF SOME BR2 IRRADIATION RIGS
P. von der Hardt Brussels, EURATOM, Sep. 1967 30 p
(Contract EURATOM-006-60-5 BRAB)
(EUR-3626.e) CFSTI: $3.00

Described is the development of capsule type irradiation devices (rigs) which were built for the Belgian Engineering Test Reactor (BR2), and irradiated during the period 1965 and 1967. Data on the history and performance of instrumented and uninstrumented rigs are summarized. A discussion of the BR2 as a materials testing reactor is also presented which includes a review of in-pile irradiation facilities and general aspects of BR2 irradiation equipment. Experiments involving UO_2 rods in NaK; UO_2 rods in an open basket; the graphite-B_4C rig; the fast neutron Be rig; general instrumented rigs; 300°C steel and 750°C graphite irradiation; 1000°C fuel ball irradiation; and 1250°C fuel particle irradiation are summarized. S.C.W.

N67-40503# General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.
REACTOR PRIMARY COOLANT SYSTEM RUPTURE STUDY Quarterly Progress Report, Jan.–Mar. 1967
May 1967 95 p refs
(Contract AT(04-3)-189)
(GEAP-5474; QPR-8) CFSTI: HC $3.00/MF $0.65

Relationships for the low-cycle fatigue mechanism of failure were developed. Additional uncertainty distributions were devised. Computer code PAPA development for the elastic analysis of piping components was completed. Problem solutions effort centered in two areas: the development of preprocessor computer codes to use with PAPA and the completion of stress calculations for a typical BWR piping system. In the experimental stress work, which is designed to provide verification of PAPA results, photoelasticity models and birefringent photoelastic coatings on metal models are being studied. The initial specimens were tested and results are being analyzed. Fractographic work conducted to correlate the features of fracture surfaces with K_{Ic} measurement is reported. The rate of growth of part-through cracks in low carbon steel plates was measured for comparison with through-wall crack growth. In crack initiation studies at 550°F, the three piping materials were tested using edge-notched plate specimens with $K_t = 3$. The first three prototype pipe fatigue tests were made on plain carbon steel, A-106B, straight pipe specimens. Author (NSA)

N67-40527# Atomic Energy of Canada, Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
RADIATION ENERGY ABSORPTION IN WR-1: MEASUREMENTS AT LOW POWER [ABSORPTION DE L'ENERGIE DES RADIATIONS DANS LE REACTEUR WR-1: MESURES FAITES A FAIBLE PUISSANCE]
M. Tomlinson, R. M. Atherley, W. G. Unruh, and A. W. Boyd Aug. 1967 28 p refs
(AECL-2763) CFSTI: HC $3.00/MF $0.65

Radiation dosimetry measurements were performed in the center of WR-1 reactor fuel assemblies to determine rates of energy absorption from fast neutrons and gamma rays. The detectors used were nickel wires for fast neutron flux, and cobalt wires for thermal neutron flux. Relative to a fast neutron flux of $1\times10^{14}/cm^2.s$, dose rate values in the center of fuel assemblies were: total dose rate in cyclohexane (C_6H_{12}) = 7.5±0.5 W/g; gamma ray contribution to dose rate in cyclohexane = 1.76±0.09 W/g; and thermal neutron flux $0.44\times10^{14}/cm^2.s$. Computer calculations gave a fast neutron flux value in agreement with measured values, and gave information on relative neutron energy absorption rates, although the computed fast neutron contribution to the energy absorption rate in cyclohexane was 26% lower than the experimental value. The results are used to estimate the rates of energy absorption in the organic coolant of the WR-1 reactor: total radiation energy absorbed = (0.58±0.06)% of fission power; fast neutron contribution = (67±7)%, under current conditions. Author

N67-40549# Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
MEASUREMENT OF THE TRANSPARENCY FACTOR AT THE RESONANCES IN D_2O MODERATED AND DIPHYL REFRIGERATED NATURAL URANIUM LATTICES [MISURA DEL FATTORE DI TRASPARENZA ALLE RISONANZE IN RETICOLI AD URANIO NATURALE MODERATI A D_2O E REFRIGERATI A DIPHYL]
D. Canalini and P. F. Cecchi 1967 42 p refs In ITALIAN
(RT/FI/67/13) CFSTI: $3.00

Measurement methods, resolution technique, and experimental results are presented for a study of resonance transparency factors in deuterium oxide and diphyl refrigerated natural uranium lattices. Activities, thermal flow clusters, and fission products are reported for neptunium 239 and uranium 235. The coincidence method used is discussed and shown in a flow chart, and some of the experimental values are plotted. Transl. by M.W.R.

N67-40584*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME III: SURFACE LABORATORY SYSTEM. PART B3: ALTERNATIVES, ANALYSES, SELECTION Final Report
31 Aug. 1967 202 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89694; F694, Vol. III, Pt. B3) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Described are surface laboratory subsystems and alternatives for each preferred design selection. Included are data on the structural/mechanical surface laboratory configuration development; the pyrotechnic subsystem; packaging and cabling; the thermal control subsystem; and the science subsystem. S.C.W.

23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

N67-39556# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Materials Lab.
AN EXPERIMENTAL APPARATUS FOR THE MEASUREMENT OF SESSILE DROP CONTACT ANGLES AT ELEVATED TEMPERATURES Technical Report, Jan.–Dec. 1966
W. L. Clow and Tung Liu Jun. 1967 20 p refs
(AFML-TR-67-152; AD-658023)

An equipment suitable for the measurement of the contact angles of molten sessile drops on solid substrate was developed. Temperatures up to 2250F may be readily controlled to within plus or minus 10F for long periods of time. The environment of the specimens may be either vacuum (to 0.00001 Torr) or a specific gas. Photographic techniques were used to record the contact angles. Experimental results of molten Na2B4O7 on metal substrates showed a standard deviation of less than 2 deg. The uncertainty introduced by the angle measurement process was shown not to exceed +2 or -2 deg. Author (TAB)

N67-39577 Joint Publications Research Service, Washington, D. C.
TECHNOLOGY OF TREATING DEEPLY CONCAVE ASPHERIC SURFACES
D. A. Khomutov 18 Oct. 1967 6 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Priborostr. (Leningrad), v. 10, no. 3, 1967 p 96–99
(JPRS-43002; TT-67-33627) CFSTI: $3.00

The article presents a method of preparing optical components with deeply concave aspheric surfaces of the second and higher orders with the aid of a set of aspheric heads. Author

N67-39610# Hughes Research Labs., Malibu, Calif.
MAGNETIC COMPRESSION OF ELECTRON BEAMS Quarterly Report, 1 Apr.–30 Jun. 1967
Kurt Amboss Ft. Monmouth, N. J., Army Electron. Command, Sep. 1967 21 p refs
(Contract DA-28-043-AMC-01463(E))
(ECOM-01463-8; QR-8; AD-658680)

The objective of this program is to compress a perveance 0.0000054 A/V to the 3/2 power electron beam by a factor of 1000 and to gain an understanding of the behavior of the beam. The experimental approach involves the probing of a scaled-up beam in suitable magnetic fields and the subsequent demonstration of compression in a sealed-off tube with a beam of the correct size. The theoretical approach has been to extend the linear optical theory to include nonlinear effects. The sealed-off beam tester was constructed and tested during this quarter. For reasons that are not yet understood, initial testing revealed no beam current to the collector. The beam tester was reassembled with a drift tube 0.034 in. in diameter replacing the 0.014 in. diameter tube, and transmission was obtained. Tests indicated that the collector had to be redesigned and that part of the body current resulted from electrons reflected from the collector. These tests are continuing. Compression experiments in the demountable beam tester on a perveance 0.000017 A/V to the 3/2 power. Author (TAB)

N67-39662# State Univ. of New York at Buffalo. Interdisciplinary Studies and Research Div.
DIFFRACTION OF PLANE ACOUSTIC PULSES BY OBSTACLES OF ARBITRARY CROSS SECTION WITH AN IMPEDANCE BOUNDARY CONDITION
Richard P. Shaw Mar. 1967 23 p refs
(Contract Nonr-4449(00); Grants NIH-FR-00126; NSF GP-56-75)
(Rept.-19; AD-657844)

The diffraction of an arbitrary acoustic pulse by an arbitrary scattering obstacle with an impedance boundary condition is treated. The problem is formulated as an integro-differential equation on surface values of pressure or velocity; this equation is then solved numerically for the specific geometry of a long cylinder of square cross section struck laterally by a step pulse in pressure. A useful economy is that the coefficients used in the approximation are independent of the boundary condition and are identical to those used for previous studies involving the same geometry. Results indicate that the surface pressure decreases from the rigid body solution for infinite impedance to an almost constant level for the boundary impedance equal to the fluid impedance. Author (TAB)

N67-39679# Stevens Inst. of Tech., Hoboken, N. J.
A COMPUTER PROGRAM FOR FACTOR ANALYSIS OF PHYSICAL PROPERTIES Interim Technical Report
E. R. Malinowski and P. H. Weiner 15 Aug. 1967 42 p refs
(Contract DA-31-124-ARO(D)-90)
(AD-658991)

The mathematical formulation of Factor Analysis is developed for the purpose of analyzing physical properties of molecules. A least-squares method of finding physically significant parameters is discussed. A computer program (FORTRAN II) for Factor Analysis is presented in order to elucidate the various steps involved, and an example problem is solved. Author (TAB)

N67-39725*# Harvard Coll. Observatory, Cambridge, Mass. Shock Tube Spectroscopy Lab.
ABSORPTION LINE SERIES AND AUTOIONIZATION RESONANCE STRUCTURE ANALYSIS IN THE ULTRAVIOLET SPECTRUM OF Sr I
William R. S. Garton (Imperial Coll.), Kenneth Codling (Imperial Coll.), William H. Parkinson, Edmond M. Reeves, and Gary L. Grasdalen Aug. 1967 43 p refs
(Grant NsG-438; Contract Nonr-1866(48))
(NASA-CR-89561; SR-21) CFSTI: HC $3.00/MF $0.65 CSCL 20F

A photoelectric spectrometer has been used to measure relative absorption cross-sections in the Sr I spectrum, over the region comprising about 22 of the autoionization resonances described in the preceding paper. The results are unfolded by a computer program into Fano-type or dispersion profiles, and values of "line-profile-indices" and autoionization damping constants are derived. One additional resonance, not recognizable from the photographic spectrum, is reported. Author

N67-39755 National Institutes of Health, Bethesda, Md.
IMPROVEMENT OF CONTRAST IN PICTURES OF THIN AMORPHOUS OBJECTS IN ELECTRON MICROSCOPY
Gaston Dupouy, Frantz Perrier, and Pierre Verdier 1966 21 p refs Transl. into ENGLISH from J. Microscop. (Paris), v. 5, 1966 p 655–668
(Rept.-7-13-67)

A method is described for improving electron microscopy image contrast by using wire as a contrast screen. The wire is placed in the back focal plane of the objective lens to stop electrons which have undergone no interaction while passing through the object and diffused electrons. Electron diffusion characteristics are discussed. Improvements in contrast obtained are illustrated using graphs, photographs, and tables which show the percentage of accelerated electrons transmitted by thin layers of graphite at 75 and 1000 kV. E.C.

N67-39901# Catholic Univ. of America, Washington, D. C.
SOUND SCATTERING BY ELASTIC CYLINDERS
R. D. Doolittle, H. Ueberall, and P. Ugincius (Naval Weapons Lab.) [1967] 54 p refs
(Contract Nonr-2249(08))
(Rept.-1-67; AD-659047)

The problem of steady-state sound scattering by an infinite elastic circular cylinder is treated by performing a Sommerfeld-Watson transformation on the normal-mode series. The complex velocities of the ensuing circumferential waves are found by obtaining zeroes of a 3 x 3 determinant in the complex plane, identical to that used by Goodman and Grace in the theory of free vibrations of an elastic cylinder. We find numerically two kinds of zeroes: (Alpha) Franz-type zeroes, similar to (and for aluminum cylinders, almost identical with) those appearing in scattering from rigid cylinders; (Beta) Rayleigh-type zeroes, as found by Goodman and Grace, which for large cylinders tend to the Rayleigh and Stoneley wave velocities, and which enter the cylinder surface at a certain critical angle. These two types correspond to the diffracted and the ordinary surface waves conjectured by Keller and Karal. We also consider the causality relations of sound pulses and show mathematically that they lead to arrival times in accord with the (complex) ray paths of Kellers theory. Finally, the trajectories of the zeroes in the complex plane for variations of ka, and the group velocities of circumferential sound pulses have been obtained. Author (TAB)

N67-40205* Scientific Translation Service, La Canada, Calif.
EXTENDED GRAVITATIONAL THEORY, MACH PRINCIPLE AND ROTATING MASSES [ERWEITERTE GRAVITATIONS-THEORIE, MACHSCHES PRINZIP UND ROTIERENDE MASSEN]
Dieter R. Brill Washington, NASA, Nov. 1967 12 p refs Transl. into ENGLISH from the German
(Contract NASw-1496)
(NASA-TT-F-11352; CTS-GR-67-2) CSCL 08N

The Jordan and Einstein theories of gravitation are compared with respect to red shifts, inertial system rotation, Mach principle and metric. Author

N67-40216* Alabama Univ., University. Dept. of Engineering Mechanics.
FEASIBILITY STUDY FOR THE CONSTRUCTION OF MEDIUM STRENGTH MAGNETIC FIELDS FOR STUDIES IN THE MECHANICAL BEHAVIOR OF MATERIALS
Arnold Dixon, Tommy C. Cruce, and A. E. Carden May 1967 13 p refs
(Grant NsG-381)
(NASA-CR-89660; MH-67-AEC-1) CSCL 20C

The mechanical behavior of materials in the presence of low-to-medium strength magnetic fields was examined. Concerning the interaction of magnetic field and plastic flow, the conclusion derived was that no major experimentation had been performed and reported in this field. Thus, two medium strength electromagnetic field structures were considered: a solenoid type field to produce a magnetic field colinear with the direction of the applied stress, and a solid core structure to produce a transverse field. With these two proposed field devices, an exploratory study of the effects of magnetic fields on material behavior was performed. Author

N67-40230# Grumman Aircraft Engineering Corp., Bethpage, N. Y.
SOME ASPECTS OF THE DETERMINATION OF THE COEFFICIENT OF FRICTION BETWEEN METALS AND SOILS AND ITS APPLICATION TO LUNAR LOCOMOTION STUDIES
Leslie L. Karafiath Oct. 1967 30 p refs
(RM-379)

The available experimental data on the coefficient of friction between metals and soils are reviewed, as are the advantages and disadvantages of the various methods to determine it. The stresses developed in granular materials from the rotating disk method applied in experiments to determine kinetic friction between metals and soils are analyzed, and the analysis is supplemented with the results of experiments both with full and with annular disks. The significance of the slip required to develop the frictional resistance is discussed in terms of its effect upon lunar locomotion. Further friction experiments in which measurement would be made of the rotational displacements with annular disks adaptable to testing in ultrahigh vacuum are proposed as a source of essential knowledge of the frictional and slip properties of soils in the lunar environment. Author

N67-40361# Pennsylvania State Univ., University Park. Osmond Lab.
RESEARCH IN THE FIELD OF HIGH RESOLUTION INFRARED SPECTROSCOPY Final Report, 1 Nov. 1963–31 Oct. 1967
T. K. Mc Cubbin, Jr. Bedford, Mass., AFCRL, 31 Jan. 1967 70 p refs
(Contract AF 19(628)-3846)
(AFCRL-67-0437; AD-659042)

Infrared spectroscopic apparatus described in AD-602 493 was further developed and it was used to investigate the spectra of CO2 and N2O. A study of the infrared amplification of the helium neon laser was made and radiation from the N2-CO2 laser was used to measure the strengths and widths of absorption lines in the 10.6 micron band of CO2. The coherent and incoherent modes of laser illumination of a spectrometer were studied. Four reprints are included with the basic text: The 02(2)0-01(1)0 band of (14)N2(16)O, J. Optical Soc. Am. v54 p956 1964; Infrared vacuum grating-prism spectrometer, App. Optics v4 p711 1965; Determination of vibration-rotational line strengths widths in CO2 using a CO2-N2 laser, App. Phys. Letters v8 p118 1966; Study of helium-neon amplification at 3.39 microns, App. Optics v4 p1412 1965. TAB

N67-40371# Air Force Cambridge Research Labs., Bedford, Mass.
ELECTRODE PHENOMENA IN A HIGH CURRENT 20 NANOSECOND SPARK Interim Report
H. Fischer and C. C. Gallagher Jul. 1967 14 p refs *Its* Phys. Sci. Res. Papers No. 335
(AFCRL-67-0446; AD-658825)

Reported here are some direct observations of the development of optical phenomena related to initial electrode processes in a 4000 A spark discharge of approximately 10 to 20 nsec duration

in 1 atmosphere air, gap 0.85mm. The development of directed flares originating from the anode spot is photographed by means of a 8 nsec Kerr cell shutter and is tentatively identified as a directed explosive type of erosion, which was predicted. Author (TAB)

N67-40373*# Farnham (Frank C.) Co., Philadelphia, Pa.
RADIATION OF AN UNDERWATER ELECTRICAL WIRE EXPLOSION [IZLUCHENIYE ELEKTRICHESKOGO VZRYVA PROVOLOKI POD VODOY]
I. V. Podmoshenskiy and N. N. Ogurtsova Washington, NASA, Oct. 1967 5 p refs Transl. into ENGLISH from Fiz. Sb., L'ovovsk. Gos. Univ. (Lvov), v. 4, no. 9, 1958 p 199–201
(Contract NASw-1497)
(NASA-TT-F-11266) CSCL 20C

The results of attempts to increase the brightness of a discharge column by using an underwater electrical explosion of wire are described. The density of the medium in which the discharge takes place is equal to unity. The wire was exploded by discharging a 25-μF capacitor through it, the capacitor having been charged to 12,000 V. The inductance of the discharge circuit was 4μH. Spectra excited during electrical explosions of wire under water, in the air, and in a capillary were photographed with an ISP-51 spectrograph. The experiments demonstrate that in the case of an underwater electrical explosion of a copper wire there is a narrow (diameter 3–4 mm) channel in the center of the discharge column, in which all the discharge energy is released. The main energy loss is caused by radiation. It is proposed that the energy transfer occurs for the most part by radiation and is similar in this regard to the energy transfer in stars. The spectrum of an underwater wire explosion was photographed by transilluminating the discharge column with a light source of far greater intensity to demonstrate the validity of this hypothesis. Results indicate that the discharge column completely absorbs the far brighter radiation exposed to it. The explosion of a wire in a capillary was the brightest since the outer layer in that case was at atmospheric pressure and its optical thickness in the continuous frequency spectrum was small. Author

N67-40374* Farnham (Frank C.) Co., Philadelphia, Pa.
EROSION OF METALLIC ELECTRODES IN A LOW-VOLTAGE SPARK [EROZIYA METALLICHESKIKH ELEKTRODOV V NIZKOVOL'TNOV ISKRE]
I. V. Podmoshenskiy and G. N. Lapina Washington, NASA, Oct. 1967 5 p refs Transl. into ENGLISH from Fiz. Sb., L'ovovsk. Gos. Univ. (Lvov), v. 4, no. 9, 1958 p 262–265
(Contract NASw-1497)
(NASA-TT-F-11267) CSCL 20C

The results of experiments performed to clarify the nature of electrical erosion of metallic electrodes in a low voltage spark are presented. In order to trace the dependence of erosion on pulse duration, the current density was fixed by limiting the discharge on the electrode surface by means of insulating disks with calibrated openings. Single sinusoidal current pulses with a large off-duty factor were produced by an electronically controlled generator. It is found that the amount of erosion increases sharply with an increase of pulse duration and that electrode polarity has little effect. An experiment was conducted to check the validity of the theory which attributes erosion to the mechanical effect of the discharge. In this experiment, the voltage across an electrode was recorded by an oscillograph to determine the energy characteristics of the portion of the discharge adjacent to the electrode. The authors propose that, in the case of long pulses, a portion of the material is removed from the electrode surface in the form of drops of liquid metal. Author

N67-40451 Technisch Physische Dienst TNO-TH, Delft (Netherlands).
STUDIES ON THE ODETA, AN APPARATUS FOR MEASURING CONTRAST TRANSFER OF OPTICAL SYSTEMS [ONDERZOEK AAN DE ODETA, EEN APPARAAT VOOR HET METEN VAN DE KONTRASTOVERDRACHT VAN OPTISCHE SYSTEMEN]
M. C. Vrolijk and W. Werner 6 Sep. 1967 43 p refs In DUTCH
(Rept.-67-0-4; TDCK-49139)

The Odeta is an optical bench for measuring the contrast transfer curvature of lenses at infinity with focal distances between the values f' = 50 mm and f' = 250 mm and diameters smaller than 100 mm. A discussion of the theoretical aspects is given which covers the spread function, intensity distributions, methods for light intensity sensing, and contrast transfer diffraction in the focus of a limiting lens. Considered are the effects of the collimator lens and the finite width of the reflection plate, the effect of the contrast transfer curvature on the opening of a film objective f' = 58 mm, and the effect of reflector location on the contrast transfer curvature of a film objective f' = 55 mm 1:4. Results are also given of measurements concerning the contrast diffraction in the focus of a single-ray doublet, comparison with three photographic objectives, and the effects of lens scattering. Transl. by K.W.

N67-40460# Eidgenossische Technische Hochschule, Zürich (Switzerland).
CONTRIBUTIONS TO THE THEORY OF SCHLIEREN OPTICS FOR LIGHT AMPLIFIERS [BEITRAEGE ZUR THEORIE DER SCHLIERENOPTIK DES LICHTVERSTAERKERS]
Theodor Kesselring (Ph.D. Thesis) 1967 64 p refs In GERMAN
(PROM-3786) CFSTI: HC $3.00/MF $0.65

Theoretical Schlieren optics studies for luminous intensity amplifiers were extended to barrier gratings and diffraction spectra. Evaluated were mercury mirrors to obtain partial light reflections, diffraction patterns from silicon gels in dark environments, as well as light reflection intensity calculations for periodic grating systems that permitted some kind of light transmission. Gel deformations with relatively weak phase transformation effects were projected by Schlieren optics with at least 1.7 amplification. Transl. by G.G.

N67-40561# United Kingdom Atomic Energy Authority, Harwell (England). Metallurgy Div.
A SUMMARY OF ELECTRON-MICROSCOPE CONTRAST THEORY
D. G. Martin Jul. 1967 22 p ref
(AERE-R-5499) CFSTI: HC $3.00/MF $0.65

Principal equations relating to electron microscope contrast theory are presented in these notes designed to supplement a text entitled *Electron Microscopy of Thin Crystals*. The scattering of an energetic electron by a free atom is treated, along with two-beam kinematical theory of the scattering of electrons by crystals containing defects. Darwin representation of two-beam dynamical theory considers differential equations for a defective crystal including absorption and for a perfect crystal neglecting and including absorption. The wave mechanical representation of the two-beam dynamical theory is discussed, and equations from this theory which describe the contrast from stacking faults and voids are included. The wave-mechanical representation of multiple beam theory for a perfect crystal is given, and equations are applied to crystals with defects. A proof shows that only the z component of the wave vector is changed when the electrons cross a foil surface. M.W.R.

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

N67-39407# California Univ., Los Angeles. Dept. of Physics.
ENERGY DEPENDENCE OF p–O^{16} ELASTIC SCATTERING BETWEEN 20 AND 50 MeV AND THE OPTICAL MODEL
John M. Cameron Jul. 1967 140 p refs
(Contracts N00014-67-A-0009; AT(11-1)-GEN-10; Nonr-233(44)) (P-80; AD-657631)

Differential cross sections for the elastic scattering of protons by oxygen were measured at incident proton energies of 23.4, 24.5, 27.3, 30.1, 34.1, 36.8, 39.7, 43.1 and 46.1 MeV. The data cover the center of mass scattering angles from 10 to 160 degrees and have a relative uncertainty smaller than 2%. The results show strong resonances to exist below 30 MeV which appreciably distort the monotonic energy variation found at the higher energies. The results were compared with those obtained by other investigators in this energy region. Total reaction cross sections for proton incident on oxygen were measured at energies of 27.2, 34.2, 40.6 and 45.2 MeV using a beam attenuation technique. The results show a slow decrease with increasing energy. A preliminary optical model analysis of the differential cross section data, together with polarization data at the same energies, was made in the energy range 30 - 40 MeV using an eleven parameter optical model search code. This analysis demonstrated that the model is able to fit the data to large scattering angles with its parameters still retaining a smooth energy dependence. The predictions for the total cross sections were in good agreement with the measurements.
Author (TAB)

N67-39427 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
EXCITATION CURVE OF THE REACTION ^{181}Ta(n,2n)^{180m}Ta [KRZYWA WZBUDZENIA REAKCJI ^{181}Ta/n,2n/^{180m}Ta]
J. Brzosko, B. Fryszczyn, E. Gierlik, A. Saganek, A. Soltan, Jr. et al 1967 13 p refs Transl. into ENGLISH from Polish
(INR-795/I/PL) Available from Nucl. Energy Inform. Center, Warsaw

The activation method was applied to measure the cross-sections producing the isomeric state of ^{180}Ta(8.12 h) formed in the reaction (n,2n), in the range of neutron energy from 12.2 MeV to 17.9 MeV. The obtained experimental values were compared with those theoretically predicted basing on the statistical model. The comparison showed a discrepancy between the experiment and the predictions of the statistical theory with Fermi gas level density.
Author

N67-39431 Polish Academy of Sciences, Cracow. Inst. of Nuclear Physics.
EXCITED STATES OF ^{155}Gd NUCLEUS [STANY WZBUDZONE JADRA ^{155}Gd]
Jan Kormicki, Henryk Niewodniczanski, Zbigniew Stachura, Kazimierz Zuber, and Alicja Budziak May 1967 44 p refs Transl. into ENGLISH from Polish Submitted for publication
(INP-546/PL) Available from Nucl. Energy Inform. Center, Warsaw

The internal conversion electron spectrum of the decay of ^{155}Tb into ^{155}Gd in the energy range from 8 keV to 600 keV was measured with the aid of a semicircular beta-ray spectrograph. The activity was produced in spallation of Ta nuclei with 660 MeV protons. The energies and relative intensities of conversion lines were measured, and for some transitions their multipolarities and mixing ratios were also determined. The obtained experimental data are presented in the decay scheme of ^{155}Tb. The decay scheme is discussed in terms of the Nilsson model, taking into account the Coriolis coupling and the interaction between states differing in oscillator quantum number by $\Delta N=2$.
Author

N67-39432 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
AN ATTEMPT OF DETERMINATION OF PROTON–NUCLEON ELASTIC CROSS SECTION IN TEV REGION [PROBA WYZNACZENIA PRZEKROJU CZYNNEGO NA ELASTYCZNE ROZPRASZANIE PROTON–NUKLEON PRZY ENERGII RZEDU TEV]
K. Rybicki 1967 6 p refs Transl. into ENGLISH from Polish Submitted for publication
(INR-P-802/VI/PH) Available from Nucl. Energy Inform. Center, Warsaw

In this experiment 5.82 m of ultra high energy proton (E>1 TeV) track were line-scanned for stars resulting from elastic scatterings on nucleons bound in emulsion nuclei. Three events of this type were found. In order to find the probability of visible evaporation of the nucleus in such process a similar scanning was performed on 24 GeV proton tracks. Proton–nucleon elastic cross section was obtained in TeV region.
Author

N67-39440 Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
CONSERVATION LAWS AND SELECTION RULES IN K-MESON DECAY. AN INTRODUCTORY SURVEY
Henry Primakoff Jun. 1967 54 p
(TH-204)

The discussion shows that the sum total of present knowledge on the decays of K-mesons: 1) is consistent with the CPT invariance of $H_{weak}+H_{elmag}$. 2) is consistent with the CP invariance of $H_{weak}+H_{elmag}$ except for the presence of the decays $K^{\circ}_2 \rightarrow \pi^+ + \pi^-$ or $\pi^\circ + \pi^\circ$. 3) is consistent with the $\Delta S = \Delta Q$ rule. 5) exhibits violations of the $\Delta I = 1/2$ rule in the CP conserving decays $K^+ \rightarrow \pi^+ + \pi^\circ$ and $K^{\circ}_1 \rightarrow \pi^+ + \pi^-$ or $\pi^\circ + \pi^\circ$ which appear to be larger than might be reasonably expected on the basis of an electromagnetic origin of the violations, and 5) exhibits relatively appreciable violations of the $\Delta I = 1/2$ rule in the CP violating decays $K^{\circ}_2 \rightarrow \pi^+ + \pi^-$ or $\pi^\circ + \pi^\circ$; however, the $\Delta I = 1/2$ rule violating matrix element in the CP conserving decays $K^{\circ}_1 \rightarrow \pi^+ + \pi^-$ or $\pi^\circ + \pi^\circ$ is large compared to the $\Delta I = 1/2$ rule violating matrix element in the CP violating decays $K^{\circ}_2 \rightarrow \pi^+ + \pi^-$ or $\pi^\circ + \pi^\circ$. A promising field of research is the investigation of leptonic and nonleptonic K-meson decays. Appreciable CP violating effects may be observed if the CP noninvariance of $H_{weak}+H_{elmag}$ resides in H_{elmag} rather than H_{weak}.
Author

N67-39448# Naval Radiological Defense Lab., San Francisco, Calif.
SENSITIVITY ANALYSIS OF THE RADIAL DISTRIBUTION MODEL. SENSITIVITY TO CARRIER MATERIAL, YIELD AND TYPE OF FISSION
Samuel H. Cassidy and Glenn R. Crocker 22 May 1967 85 p refs
(USNRDL-TR-67-70; AD-658327)

A method was previously developed for calculating the distribution of fission-product nuclides among fallout particles as a function of size. Calculations from this Particle Activity Module of radionuclide fractionation in land-surface nuclear bursts were tested for sensitivity to three kinds of input parameter variation: (1) variation in weapon yield, (2) variation in type of fission and (3) difference in solidification temperature of the carrier material (silicate soil or coral). During the calculations a fourth input parameter, particle-size distribution, was unchanged. The calculations show the model to be relatively insensitive to variation in weapon yield and type of fission. The calculations at a solidification temperature

appropriate to coral (2887K) indicated that particles smaller than 47 microns in diameter contribute about 70% of the total exposure rate, while the calculations at the silicate soil solidification temperature (1673K) indicate about 60%. The proportions of the 1-hr exposure-rate contributed by volatile, mixed, and refractory fission-product chains are considerably different for the two solidification temperatures. The temperature sensitivity of the model should be investigated in more detail, since there is reason to believe that changes in fractionation behavior which are not apparent at 1 hour after burst might be important at later times.
Author (TAB)

N67-39451# Naval Radiological Defense Lab., San Francisco, Calif.
CHARGED PARTICLE TRACKS IN POLYMERS NO. 4: CRITERION FOR TRACK REGISTRATION
Eugene V. Benton 10 Jul. 1967 33 p refs
(USNRDL-TR-67-80; AD-658325)

A new criterion for track registration in polymer charged particle detectors is proposed. Based on the concept of the restricted energy loss rate, it indicates that only energy transfer collisions of 1.0 plus or minus 0.2 keV and less are important in track formation. For track registration in cellulose nitrate and Lexan, a charged particle must have a restricted energy loss rate of 1.1 and 3700 MeV sq cm/g respectively. This threshold appears to be sharp in both materials.
Author (TAB)

N67-39481# Lincoln Lab., Mass. Inst. of Tech., Lexington.
FINITE TEMPERATURE THEORY FOR THE ATTENUATION OF QUASI-PARTICLE EXCITATIONS IN REAL METALS
Richard W. Davies 14 Aug. 1967 27 p refs
(Contract AF 19(628)-5167)
(ESD-TR-67-336; TN-1967-39; AD-657776)

The finite temperature generalization of the Quinn, Adler theory for the decay rate of electronic excitations in a normal Fermion system is presented. The theory is developed in terms of quasi-particle parameters and without restriction to a particular approximation, such as RPA, for the dielectric response of the system. The relations derived are pertinent to the lifetime problem in real solids; in particular, local field effects are rigorously taken into account.
Author (TAB)

N67-39528# Uppsala Univ. (Sweden). Quantum Chemistry Group.
CONTINUED FRACTIONS AND UPPER AND LOWER BOUNDS IN THE BRILLOUIN–WIGNER PERTURBATION SCHEME
Osvaldo Goscinski 31 Jan. 1967 19 p refs *Its* Preprint No. 187
(Contract AF 61(052)-874)
(SR-26; AD-658035)

A derivation of approximants to a continued fraction development of the energy is presented. It is based on the techniques of infinite order perturbation theory and inner projection of operators. The approximants have been introduced before; here their formal nature is clarified and conditions under which they exhibit extremal properties are presented. The oscillatory behaviour about the true eigenvalue, observed previously in the Mathieu problem, is explained.
Author (TAB)

N67-39531# Idaho Nuclear Corp., Idaho Falls. National Reactor Testing Station.
SEARCH FOR THE KOHN EFFECT IN LIQUID LEAD
P. D. Randolph Jun. 1967 19 p refs
(Contract AT(10-1)-1230)
(IN-1094)

Recent theoretical calculations have shown that the so-called Kohn anomaly may be observable by neutron scattering in liquid metals, thus furnishing a new way of measuring the Fermi Surface in these materials. The effect is expected to appear as a discontinuity in a curve of quasi-elastic widths as a function of neutron momentum transfer. The MTR phased-chopper velocity selector was used for slow neutron scattering measurements of the quasi-elastic widths in liquid lead at 350°C. These measurements were made at six incident energies in the range $0.015 \leq E_0 \leq 0.025$ eV and span momentum changes $\hbar\kappa$ in the range $1.8 \leq \kappa \leq 4.5$ $Å^{-1}$. No Kohn anomaly was observed within the accuracy of the experiment. The variation of the widths agrees with the calculations of DeGennes at the first diffraction maximum and minimum, but not at large κ.
Author (NSA)

N67-39551# Army Nuclear Defense Lab., Edgewood Arsenal, Md.
NEUTRON SPECTROSCOPY WITH NUCLEAR EMULSIONS
Austin W. Barrows and Richard V. Mancuso Jul. 1967 35 p refs
(NDL-TR-92; AD-658067)

A method is described for measuring neutron energy spectra with nuclear emulsions. The normal concentration of hydrogen in the emulsion serves as the proton radiator. It is concluded that neutron groups separated by 400 keV or more and in the energy range of 2 to 15 MeV can be resolved. Preliminary results from the study of the C12(n,n)3 alpha reaction using emulsions are also discussed.
Author (TAB)

N67-39553# Miami Univ., Coral Gables, Fla. Center for Theoretical Studies.
DYNAMICAL THEORY OF BARYONS AND LEPTONS
Behram Kursunoglu Aug. 1967 57 p refs
(Grant AF-AFOSR-1268-67)
(CTS-HE-67-4A; AD-657959)

The paper is an attempt for a dynamical description of baryons and leptons by the same wave equation yielding different mass spectra for each one of them. The wave equation leads to the following results: (1) mass spectra for leptons and baryons (represented by orthogonal states) in the form of singlets and doublets, (2) a third neutrino along with a third neutral lepton are predicted, (3) the group SU(3,1) assumes the role of an internal symmetry group; thus pointing to the possibility of space time origin of internal symmetries. The theory is obtained from a classical non-linear (Born-Infeld type) Lagrangian depending on the field variables E and H and only the wave equation for spin 1/2 particles is discussed. In this approach the field itself is treated as a wave function and therefore a way is found to get rid of Born type square root. The wave equation involves, besides Dirac matrices, the 15 six-dimensional generators of the group SU(3,1). It is invariant under G = SL(2,C) x SU(3,1) x L transformations, where the direct product contains the Lorentz group L.
Author (TAB)

N67-39569# Texas Univ., Austin. Dept. of Physics.
THE PHYSICS OF METASTABLE SYSTEMS Final Report, 1 Feb. 1966–31 Jan. 1967
W. W. Robertson 31 Jan. 1967 13 p refs
(Grant AF-AFOSR-66-273)
(AFOSR-67-1988; AD-657805)

A summary is given of studies involving the various processes for the production and destruction of energetic species of the rare gases. The program of investigation involved the determination of all the various mechanisms for reaction together with the rate constants and the dependence of these upon gas and electron temperatures, densities, impurities, container size and walls, etc.

Many of these reactions were investigated in active discharges as well as in afterglows. The main diagnostic tool was spectroscopy, either emission or absorption depending upon the nature of the system under investigation. TAB

N67-39802# Uppsala Univ. (Sweden). Quantum Chemistry Group.
ASYMPTOTIC EXCHANGE COUPLING AND THE AMO METHOD
E. Bosatta and O. Goscinski 1 May 1967 7 p refs *Its* Preprint No. 191
(Contract AF 61(052)-874)
(SR-30; AD-658036)

The calculation of the exchange coupling constant for two hydrogen atoms with the Heitler and London method gives the wrong sign in the asymptotic limit. The AMO formalism is used to show that the mixing of the polar state does not give an improvement. Author (TAB)

N67-39812# Uppsala Univ. (Sweden). Quantum Chemistry Group.
THE GROUND STATE OF ATOMIC TWO-ELECTRON SYSTEMS IN THE INDEPENDENT PARTICLE MODEL
Marten J. ten Hoor 1 Jul. 1967 31 p refs *Its* Preprint No. 195
(Contract AF 61(052)-874)
(SR-34; AD-658037)

Scaled variational functions of the form (Phi sub alpha(k)) = e exp. -(Z-1+e exp. -(alpha(kr)))kr, where Z is the nuclear charge and alpha is a parameter, and (Phi sub beta(alpha)(k)) = exp. -(beta + e exp -(alpha(kr)))kr, where both alpha and beta are parameters, are used for the description of the ground state of atomic two-electron systems in the independent particle model. The scale factor k has been introduced in order to satisfy the virial theorem. Apart from the energy, a number of one-electron expectation values have been calculated and the results are compared with those obtained from other variational functions. The function (Phi sub alpha(k)) yields already a good approximation to the Hartree-Fock solution whereas with the function (Phi sub beta(alpha)(k)) the Hartree-Fock results are practically reproduced. Author (TAB)

N67-39832*# IIT Research Inst., Chicago, Ill. Technology Center.
PREDICTION OF NEUTRON INDUCED ACTIVATION. VOLUME I: NAP CODE MANUAL Final Report, May 14, 1964-Jan. 31, 1966
David A. Klopp 31 Jan. 1966 215 p
(Contract NAS8-11160)
(NASA-CR-89654; IITRI-A6088-21, Vol. I) CFSTI: $3.00 CSCL 18H

An IBM 70904 computer program was written for the prediction of neutron induced activation. The preparation of input data and the interpretation of output data are described. Flow charts for the main program and each subroutine are given, as well as a complete program listing in Fortran IV. A sample problem is also presented. Author

N67-39868# Los Alamos Scientific Lab., N. Mex.
ATOMIC STRUCTURE CALCULATIONS. I: HARTREE-FOCK ENERGY RESULTS FOR THE ELEMENTS HYDROGEN TO LAWRENCIUM
Joseph B. Mann 1 May 1967 77 p refs
(Contract W-7405-ENG-36)
(LA-3690) CFSTI: HC $3.00/MF $0.65

Hartree-Fock calculations of the electronic structure and energies of the elements from hydrogen to lawrencium were made. Exchange terms were included without approximation. Tabulations of total atom energies, orbital binding energies, I, F, and G energy integrals, and orthonality parameters ϵ_{ij} for open shells are presented here. The procedures for solving the Hartree-Fock equations on the IBM 7030 (Stretch) computer are described. Author (NSA)

N67-39893# California Inst. of Tech., Pasadena.
THE SPIN AND BRANCHING OF THE 2750-KEV LEVEL IN ^{37}K
D. R. Goosman Jul. 1967 16 p refs
(Contract Nonr-220(47))
(AD-657091)

Previous work has shown that the spin of the 2750-keV level in potassium-37 is either 3/2(+) or 5/2(+). To resolve the ambiguity, two experiments were carried out. The linear polarization of the ground-state gamma ray from the 2750-keV level was measured. The weak cascade from the 2750-keV level through the doublet near 1.37 MeV was shown to involve the 1380-keV level. These results exclude a spin of 3/2(+) for the 2750-keV level, and the spin is established to be 5/2(+). Author (TAB)

N67-39921* Scientific Translation Service, La Canada, Calif.
THEORY OF FORMATION OF NEGATIVE IONS DURING SLOW COLLISIONS OF ATOMS [K TEORII OBRAZOVANIYA OTRITSATEL'NYKH IONOV PRI MEDLENNYKH ATOMNYKH STOLKNOVENIYAKH]
R. Z. Vitlina and A. V. Chaplik Washington, NASA, Oct. 1967 9 p refs Transl. into ENGLISH from Zh. Eksperim. Teor. Fiz. (Moscow), v. 52, no. 4, 1967 p 959-965
(Contract NASw-1496)
(NASA-TT-F-11327) CSCL 20H

The effect on an electron of nonstationary disturbance which produces a bound s-state at a certain moment of time during a slow collision of atoms is discussed. The electron capture probability in a discrete level and the electron energy distribution in the continuous energy spectrum of an atom are determined in an adiabatic approximation. The relation of these processes to the formation of negative ions during slow collisions is demonstrated. Author

N67-39936 Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
IS SATURATION A GOOD APPROXIMATION TO SUM RULES?
B. Diu Sep. 1967 9 p refs
(TH/216)

A mathematical discussion is presented on superconvergence, saturation, and bootstrap considerations for the static model. It is concluded that care must be taken in using saturation as a test for a particular sum rule. N.E.N.

N67-39944# Miami Univ., Coral Gables, Fla. Center for Theoretical Studies.
LEPTONIC TRIPLETS
Behram Kursunoglu Aug. 1967 11 p refs
(Grant AF-AFOSR-1268-67)
(CTS-HE-67-5; AD-657984)

A neutral lepton e-o of mass m-o = 1.00486 m-e and an associated third neutrino nu-o were predicted from a recent theory of baryons and leptons. The decays neutral-K-2 to neutral-pion + antineutrino + neutral-lepton to gamma ray + neutrino neutral-K-2 to antineutrino + neutral-lepton to gamma-ray + neutrino, etc. are discussed for a possible experimental search of these particles. Author (TAB)

N67-39947# California Inst. of Tech., Pasadena.
RADIATIVE CAPTURE OF ^{3}He BY ^{3}He
W. D. Harrison, W. E. Stephens, T. A. Tombrello, and H. Winkler Jun. 1967 19 p refs
(Contract Nonr-220(47))
(AD-657619)

The reaction 3He + 3He to 6Be* + gamma was observed at 90 deg. for bombarding energies between 0.86 and 11.8 MeV. The total cross section for transitions to the first excited state of 6Be varies smoothly from 0.4 to 9.3 microbarns (assuming isotropy). No gamma-ray transitions to the ground state of 6Be were observed with an upper limit of approximately 0.01 microbarns at 1.4 MeV. Because of these low cross sections, this reaction is of negligible astrophysical importance compared to the 3He(3He,2p)4He reaction. Author (TAB)

N67-40031# Istituto Superiore di Sanita, Rome (Italy). Lab. di Fisica.
GAUGE INVARIANCE PROPERTIES OF AN INTERACTING BOSE SYSTEM [PROPRIETA DI INVARIANZA DI GAUGE DI UN SISTEMA DI BOSONI INTERAGENTI]
F. de Pasquale and E. Tabet 17 Jun. 1967 14 p refs
(ISS-67/15) CFSTI: HC $3.00/MF $0.65

Previous results on gauge invariance properties for a Bose system are extended to the finite temperature case. A discussion of sum rules for a superfluid Bose system is also given. Author

N67-40057# Pittsburgh Univ., Pa.
SPACE RESEARCH COORDINATION CENTER. TWO AND THREE PARTICLE COULOMB SYSTEMS
Gerald L. Nutt 11 Aug. 1967 28 p refs
(Contract Nonr-624(16))
(SRCC-53; AD-658540)

The Coulomb T-matrix is examined in a two body and a three body Hilbert space. The purpose is to demonstrate how this function may be used to construct the Faddeev three body kernel. In the process the apparent paradox of the indefiniteness of the Coulomb T-matrix on the energy shell is resolved. The question of off shell unitarity is discussed. Author (TAB)

N67-40058*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CORE EXCITATION IN SILVER, INDIUM, AND ANTIMONY RESULTING FROM INELASTIC SCATTERING OF 42-MEV (6.7-PJ) ALPHA PARTICLES
William M. Stewart, Norton Baron, and Regis F. Leonard Washington, NASA, Nov. 1967 41 p refs
(NASA-TN-D-4222) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Alpha particles of energy 42 MeV (6.7 pJ) have been elastically and inelastically scattered from isotopes of silver, indium, and antimony in an attempt to excite states which may be describable in terms of an excited core model. Angular distributions ($30^{\circ} \leq \theta_{cm} \leq 80^{\circ}$) were measured for excited states of all nuclei. In each isotope, a number of states have been excited with cross sections of the right order of magnitude to indicate that they are collective in nature. The data obtained are compared with that for the appropriate neighboring even-even cores (palladium, cadmium, tin, or telluruim) with respect to the strength of the excitation, the excitation energy, and the multiplicity of states observed. It appears that fairly good agreement with the excited core model is obtained for indium and somewhat less good agreement for the isotopes of silver and antimony. The energy resolution of the present experiment prohibits any strong statements concerning the multiplicity of excited states. Author

N67-40089 Polish Academy of Sciences, Cracow. Inst. of Nuclear Physics.
TERNARY FISSION OF U^{238} Th^{232} NUCLEI INDUCED BY 2.9 MEV NEUTRONS [TROJROZSZCZEPIENIE JADAR U^{238} I Th^{232} BOMBARDOWANYCH NEUTRONAMI O ENERGII 2.9 MEV]
J. Benisz Jun. 1967 22 p refs Submitted for publication
(INP-547/PL)

The ternary fission mechanism of uranium 238 and thorium 232 induced by 2.9 MeV neutrons was investigated. Two modes of ternary fission of uranium 239 and thorium 233 were determined. The average total kinetic energy of fragments was found to be 182 MeV for ternary fission of uranium 239 and 165 MeV for ternary fission of thorium 233. The frequency of occurrence of ternary fission relative to binary fission was found to be 9×10^{-4} for fission of uranium 238 induced by 2.9 MeV neutrons and 3×10^{-3} for fission of thorium 232 induced by 2.9 MeV neutrons. Author

N67-40129# India. Dept. of Atomic Energy, Bombay.
ANNUAL REPORT OF THE DEPARTMENT OF ATOMIC ENERGY, GOVERNMENT OF INDIA
1967 75 p
CFSTI: HC $3.00/MF $0.65

An overview is presented on the various activities and accomplishments of the several divisions comprising the Bhabha Atomic Research Center (BARC). These include: (1) full utilization of the three reactors for isotope production and research; (2) preparation of high purity chemicals, along with organic and inorganic compounds labeled with heavy hydrogen to meet the requirements within BARC; (3) development of a metatheoretic model to handle programming languages and computers within a uniform framework; (4) building, testing, and calibrating a speech spectrum analyzer; (5) development of a picture-processing language to simulate a hand-printed English letter generator; (6) research on treatments for gullet, check, and tongue cancers; and (7) space research, including the launching of sounding and meteorological rockets. M.G.J.

N67-40180# Instituto Superiore di Sanita, Rome (Italy). Lab. di Fisica.
NUCLEAR STRUCTURE DETERMINATION FROM 20 GeV PROTON SCATTERING [DETERMINAZIONE DELLA STRUTTURA NUCLEARE PER MEZZO DELLA DIFFUSIONE DI PROTONI DE 20 GeV]
R. J. Glauber and G. Matthiae 29 Jun. 1967 15 p refs
(ISS-67/16) CFSTI: HC $3.00/MF $0.65

Experimental data on the scattering of 20 GeV protons by nuclei are analysed using the multiple diffraction theory of high energy collisions. The information which is obtained on the nuclear structure is compared with the results of the electron scattering experiments. Author

N67-40249# General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science.
STATUS OF THERMAL NEUTRON SPECTRA
J. R. Beyster and J. M. Neill 9 Jun. 1967 44 p refs Presented at the Symp. on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich., 17–21 Jul. 1967
(Contract AT(04-3)-167)
(GA-7092; CONF-670707-7) CFSTI: HC $3.00/MF $0.65

Some improvements in methods of calculating and measuring thermal neutron spectra are reviewed together with the status of spectral measurements. NSA

N67-40250 Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).

A COVARIANT THEORY OF PION–DEUTERON ELASTIC SCATTERING

D. Schiff and J. Tran Thanh Van Aug. 1967 64 p refs

(TH-212)

The elastic pion deuteron scattering is studied in a fully covariant theory in which special attention is given to the treatment of inelastic unitarity. From a study of the box diagram singularities, the leading contributions are found to come from the impulse graphs, i.e., the two pion exchange in the t channel and the nucleon nucleon and the pion nucleon intermediate states in the s channel. The πNN state is approximated by an NN* state and the instability of N* is taken into account. The correction terms are due to the binding, multiple scattering and absorption processes. These effects have been calculated and dispersion relations for the partial wave amplitudes are used. A detailed comparison with experiments for pion energy in the laboratory system at 85, 142, 300 and 325 MeV shows an excellent agreement. Author

N67-40269# General Dynamics/Convair, San Diego, Calif. Space Science Lab.

INTERMOLECULAR POTENTIAL ENERGIES BY A MOLECULAR BEAM SCATTERING METHOD Annual Report, 1 May 1966–30 Apr. 1967

Erhard W. Rothe May 1967 6 p refs

(Contract AF 49(638)-1730)

(GDC-DBE-67-017; AFOSR-67-2011; AD-657784)

A crossed molecular beam machine was constructed and tested. Mechanical velocity selection is used to obtain monoenergetic beams. Each beam is chopped, and the resulting doubly modulated output signal is analyzed. The energy range is from 0.02-0.95 eV. The velocity dependence of the total collision cross section was measured for the scattering of lithium atoms by 18 different atoms and molecules. Data analysis is not complete, but the results will lead to potential energy information relevant to chemical reactions. Author (TAB)

N67-40273# Aerospace Corp., Los Angeles, Calif. Labs. Div.

A NUMERICAL SINGLE-CENTER SELF-CONSISTENT FIELD FUNCTION FOR THE HYDROGEN MOLECULE

Roger L. Wilkins and Howard S. Taylor (Univ. of Southern Calif.) Jun. 1967 40 p refs

(Contract AF 04(695)-1001)

(TR-1001(2240-20)-15; SSD-TR-67-133; AD-658447)

A Hartree-Fock single determinant wave function is calculated for the normal state (1)Sigma(+)g of the hydrogen molecule. The one-electron molecular orbitals in this determinant are expanded up to fourth-order terms as a product of a series of spherical harmonics and radial wave functions about the molecular midpoint of the molecule. The potential field caused by the nuclei is expanded in spherical harmonics up to eighth-order terms, and the complete Hartree-Fock equations are set up and solved numerically for the three radial functions occurring in one-electron molecular orbitals. The numerical technique used to solve the three coupled second-order differential-integral equations differs from that usually used in atomic calculations. The total molecular energy obtained from this numerical approximation is -1.14100 a. u., which is a small improvement over the total analytic self-consistent energy of -1.13363 a. u. obtained by Kolos and Roothaan using nine-term orbitals. This calculation shows that the best Hartree-Fock Roothaan self-consistent field (SCF) molecular wave function must be very close indeed to the true Hartree-Fock SCF molecular wave function. Author (TAB)

N67-40328# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy).

FINITE DIFFERENCE EQUATIONS CALCULATION OF BEAM-CAVITY COUPLING INSTABILITY

M. Bassetti 5 Jul. 1967 42 p refs *Its* Nota Interna No. 369

(LNF-67/45) CFSTI: HC $3.00/MF $0.65

The problem of the influence of the beam loading on the stability of the coherent synchrotron oscillations is resumed and discussed in this work by means of finite difference equations, i.e., in a way that differs from the ones employed by preceding authors. Author

N67-40332# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati.

SOME CONSIDERATIONS ON THE POSSIBILITY OF OBTAINING A QUASI-MONOCHROMATIC POLARIZED PHOTON BEAM FROM LASER-ELECTRON SCATTERING IN THE STORAGE RING ADONE

R. Malvano, C. Mancini, and C. Schaerf 17 Jul. 1967 12 p *Its* Internal Note No. 372

(LNF-67/48) CFSTI: HC $3.00/MF $0.65

The possibility of using the electron beam of the Adone storage ring as a source of an intermediate energy quasi-monochromatic photon beam is discussed. The beam is obtained from the Compton scattering of coherent light from an argon gas laser on the high energy electrons circulating in the storage ring. Results of numerical computations on the interaction of a light photon and a fast moving electron are summarized. The duty cycle and polarization of the photon beam are briefly discussed and the energy spectrum of the background source is calculated. R.N.A.

N67-40379# General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science.

NEUTRON SCATTERING IN BERYLLIUM

Juan U. Koppel and James A. Young 12 Jun. 1967 13 p refs Presented at the Symp. on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich., 17–21 Jul. 1967

(Contract AT(04-3)-167)

(GA-8031; CONF-670707-11) CFSTI: HC $3.00/MF $0.65

The phonon dispersion curves and frequency spectrum for beryllium are calculated using the adiabatic approximation. NSA

N67-40380# General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science.

MULTIPLE SCATTERING IN NEUTRON DOUBLE DIFFERENTIAL CROSS SECTION MEASUREMENTS

E. L. Slaggie 13 Jun. 1967 18 p refs Presented at the Symp. on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich., 17–21 Jul. 1967

(Contract AT(04-3)-167)

(GA-8052; CONF-670707-6) CFSTI: HC $3.00/MF $0.65

Some methods of correcting double differential data for multiple scattering are reviewed, and the double differential scattering of 0.039-eV neutrons by a slab of water at room temperature is treated as a numerical example. The effects of varying the thickness of the sample are studied. The corrections for double differential scattering by zirconium hydride are also treated as an example. NSA

N67-40381# Deutsches Elektronen-Synchrotron, Hamburg (West Germany).

PHOTOPRODUCTION OF MULTIPION SYSTEMS

H. Satz May 1967 7 p refs

(DESY-67/17)

Combining vector meson dominance and the quark model with isospin independence of production reactions above the resonance region, the cross sections for multipion photoproduction from the corresponding π-N data are predicted. Author (NSA)

N67-40382# General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science.
ANGULAR SCATTERING BY C_2 $ZrH_{1.85}$ AND C_6H_6
R. Beyster, G. M. Borgonovi, and G. W. Carriveau 12 Jun. 1967 20 p refs Presented at the Symp. on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich., 17–21 Jul. 1967
(Contract AT(04-3)-167)
(GA-8030; CONF-670707-8) CFSTI: HC $3.00/MF $0.65

The single differential angular cross sections for scattering of neutrons by CH_2, $ZrH_{1.85}$, and C_6H_6 were measured using a time-of-flight technique. The measurements in CH_2 and C_6H_6 were made at room temperature, while the measurements in $ZrH_{1.85}$ were made at room temperature at 700°K. The experimental results were compared with theoretical predictions. NSA

N67-40388# Deutsches Elektronen-Synchrotron, Hamburg (West Germany).
MEASUREMENTS ON THE FORMATION, GROWTH, AND RECOMPRESSION OF BUBBLES IN LIQUID HYDROGEN
G. Harigel, G. Horlitz, and S. Wolff May 1967 39 p refs
(DESY-67/14)

In the 85 cm bubble chamber photographs of electron tracks with a momentum of about 2 GeV/c were taken with a scale-one optical system in bright-field illumination. Growth and recompression of bubbles as well as bubble density were observed between 24.5 and 28.0°K. Bubble radius as a function of time was measured at different temperatures, with minimum and static pressures as variable parameters. A comparison between different theories on the behavior of bubble growth and recompression is given. Author (NSA)

N67-40406# Giessen Univ. (West Germany).
INTERACTIONS OF FISSION FRAGMENT IONS WITH MATTER [WECHSELWIRKUNGEN VON SPALTPRODUKTIONEN MIT MATERIE]
E. Konecny, D. Kerr, G. Siegert, and H. Gunther Jun. 1967 28 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-56)

The mass spectrometer installed at the Reaktorstation Garching has been used to investigate the interaction of high-energy heavy ions with matter. The results of an experiment in which the multiple and plural scattering distributions of fission fragments were measured can be reproduced by the theory of Molière while the theory of Nigam, Sundaresan and Wu predicts distribution widths that are as much as four times too large. The electron capture cross sections for fission fragments in air, helium, and methane were measured. Author (NSA)

N67-40456# Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica.
ACTIVATION OF ^{111}Cd BY γ-RAYS SCATTERING IN RESONANCES [SULL'ATTIVAZIONE DELL ^{111}Cd MEDIANTE DIFFUSIONE DI γ IN RISONANZA]
G. Canella 4 Sep. 1967 20 p refs In ITALIAN; ENGLISH summary
(ISS-67/22)

^{111}Cd specific activation versus irradiated sample thickness by ^{60}Co γ-rays source was calculated and experimentally shown. ^{111}Cd activation level was found in practice superposed on the 1.332 MeV level of ^{60}Co γ-rays emission Author

N67-40457 Polish Academy of Sciences, Cracow. Inst. of Nuclear Research.
PHASE SHIFT ANALYSIS FOR THE ELASTIC SCATTERING OF PARTICLES ON ATOMIC NUCLEI. PROGRAM PCS FOR THE ODRA 1003 COMPUTER [ANALIZA PREZESUNIEC FAZOWYCH DLA ROZPRASZANIA ELASTYCZNEGO CZASTEK NA JADRACH ATOMOWYCH. PROGRAM PCS NA MAZYNE ODRA 1003]
A. Slizynski May 1967 45 p refs In POLISH; ENGLISH summary
(INP-532/PL)

A program for computing angular distributions for elastic scattering of particles on atomic nuclei which was designed for use with the ODRA 1003 digital computer; is described. The angular distributions calculated with phase shifts given in numerical or analytical form could be fitted to experimental angular distributions. Author

N67-40466# Air Force Cambridge Research Labs., Bedford, Mass. Upper Atmosphere Physics Lab.
CLASSICAL AND QUANTAL CALCULATIONS ON ELECTRON CAPTURE
Robert A. Mapleton (Ph.D. Thesis—Queens Univ., Belfast, Northern Ireland, 21 Dec. 1966) Jun. 1967 324 p refs
(AFCRL-67-0351; PSRPP-328; AD-658445)

Classical and quantal nonrelativistic scattering between simple atomic systems is reviewed, and most approximations currently used in calculations on electron capture are discussed. The OBK interaction is generalized to include capture from neutral atoms by singly charged many-electron ions; the sum over the squares of the vector coupling coefficients is affected in the formula for the OBK cross section for p-orbital capture by protons into H(ns). The cross section for H(+) + H(1s) to H(Sigma n1) + H(+) at high impact energies is determined classically. The second Born amplitudes at high impact energies for H(+) + H(1s) to H(1s) + H(+) and H(+) + D(1s) to H(1s) + D(+) are evaluated approximately using the Greens function of the post Hamiltonian. Two modifications of Thomas classical model for heavy atoms are proposed, and corresponding cross sections are calculated for H(+) + B to H(Sigma n1) + B(+) with B = O, N, Ne, A, Kr, Xe. A semiclassical theory is developed for charge transfer in alkali atom-alkali-ion collision at low impact velocities, and cross sections are obtained for H, Li, Na, K, Rb, Cs. OBK cross sections are calculated for s-orbital capture from He(1s(2)), N((4)S), O((3)P), and p-orbital capture from N((4)S), O((3)P), all for incident protons capturing into H(1s). Born prior and post cross sections are calculated for H(+) + O((3)P) to H(1s) + O(+)((4)S) and H(1s) + H(1s) to H(-)(1s(2)) + H(+). TAB

N67-40467# Boeing Scientific Research Labs., Seattle, Wash. Solid State Physics Lab.
USE OF LINEAR NONSYMMETRIC EIGENVALUE EQUATIONS FOR A SUM-OVER-POINTS APPROACH: APPLICATION TO H_2
Charles M. Carlson Sep. 1967 18 p refs
(D1-82-0644; AD-658793)

Linear eigenvalue equations Summation, j=1 to j=n sub c of (c sub j (H sub ij - epsilon S sub ij)) = 0 in which the matrix components, H sub ij and S sub ij, as in the local energy method of Frost and coworkers, are sums over sets of points are proposed for computing approximate ground state eigenvalues epsilon and eigenvectors c sub j for the linear trial wave function phi = Summation, j=1 to j=n sub c of (c sub j phi superscript j). Results paralleling those obtained by Frost, Kellogg and Curtis were achieved using these equations for calculations on H2+ employing the same sets of points and basis functions. TAB

N67-40478# Akademiya Nauk URSR, Kharkov. Fiziko-Tekhnicheskii Inst.
COINCIDENCE OF REGGE TRAJECTORIES AND SU(2)$^{1}_{w}$
D. V. Volkov 1966 4 p refs
(FTI-LA-1)

A symmetry group for the nucleon–meson interaction is considered, which follows from (1) the analyticity of the nucleon–antinucleon scattering amplitudes at t = 0 (t is the total nucleon–antinucleon energy squared) and (2) the assumption that mesons belong to Regge trajectories and the trajectories intersect the j-axis (in the j–t plane) near the integer points. It is shown that relations satisfied by the helicity partial wave amplitudes are a consequence of the SU(2)$^{1}_{w}$ group. NSA

N67-40480# Cornell Univ., Ithaca, N. Y.
ENERGETIC PARTICLES AND THE BACKGROUND RADIATION
Kenneth Greisen [1967] 52 p refs Presented at the 1967 Texas Symp. on Relativistic Astrophys., New York
(Contract AT(30-1)-3038)
(NYO-3038-7; CONF-670119-1) CFSTI: HC $3.00/MF $0.65

The effects of the interaction of background radiation with energetic particles fall into two classes, both of which are of potential interest in proofing the external universe: absorptive effects and productive effects. After a brief survey of the nature of the radiation field itself, the following are discussed: absorption effects: (1) energy drain on fast electrons, (2) absorption of high-energy photons, (3) breakup of cosmic nuclei, and (4) energy drain on fast protons: Produced radiation; (1) diffuse X and γ radiation from all space, (2) X and γ radiation by Doppler-shifted reflection from discrete sources, (3) vacuum cascade leading to a prominence in the photon spectrum between 10^{13} and 10^{14} eV, (4) primary photons around 10^{19} eV, (5) primary high-energy neutrons, and (6) very high-energy neutrinos. NSA

N67-40481# Atomic Energy Commission Research Establishment, Lucas Heights (Australia).
SEMICLASSICAL MODEL OF DIRECT REACTIONS
I. Robertson May 1967 10 p refs
(AAEC/TM-388)

The semiclassical model of direct reactions is reviewed, and its predictions are presented for a reaction which exhibits the phenomenon of backward peaking, following the work of Pearson. The curve σ (180°) versus energy is fitted quite closely; the shape of the curve has a simple explanation in terms of the bound-state radial wave functions. To check the validity of the model, the corresponding distorted-wave Born approximation (DWBA) calculations are carried out; little agreement is found. The semiclassical model severely overestimates the spatial localization in the exact matrix element, and therefore gives cross sections which have a much faster energy variation than the DWBA cross sections. The DWBA calculation can not explain the experimental results on backward peaking, and it is concluded that the agreement between the semiclassical model and experiment is fortuitous. Author (NSA)

N67-40486 Polish Academy of Sciences, Cracow. Inst. of Nuclear Physics.
OPTICAL MODEL PROGRAMME WITH THE AUTOMATIC SEARCH ROUTINE ALA-1 [PROGRAM AUTOMATYCZNY ALA-1 DLA OBLICZEN MODELEM OPTYCZNYM]
Alicja Dudek May 1967 43 p refs
(INP-553/PL)

A program for the computation of differential cross-sections and polarizations of particles elastically scattered on complex nuclei is presented. The program permits an automatic search over the space of the nuclear optical model parameters, yielding optimum fit to experimental cross-sections. Author

N67-40492 Atomic Weapons Research Establishment, Aldermaston (England).
THE PRODUCTION OF NUCLEAR TARGETS BY VACUUM EVAPORATION
G. T. J. Arnison May 1967 42 p refs
(AWRE-O-32/67) HMSO: 9s 0d

The basic physical principles involved in vacuum evaporation of thin film nuclear targets are reviewed, and methods and techniques of producing such films are surveyed. These include crucibles and evaporation sources, electron bombardment for heating materials, the choice of a substrate temperature to produce a homogeneous ductile film, stripping agents, the rates of evaporation and condensation on the substrate, the uniformity of evaporation, and the use of carbon backings for materials which are not easily produced in a self-supporting film. The usual evaporation techniques for various materials are listed, together with information about crucible yields and substrate distances. Target packaging methods are considered, and it is reported that the problems involved in shipping have been overcome by packing the targets in a vacuum desiccator which is contained in a specially molded wood wool packing inside a heavy cardboard box. M.G.J.

N67-40496 European Organization for Nuclear Research, Geneva (Switzerland).
SELECTED TOPICS ON VIOLATION OF CP INVARIANCE
L. Caneschi and L. Van Hove 22 Sep. 1967 55 p refs
Lectures given in Geneva, May–Jun. 1967
(CERN-67-27)

Consideration is given to elementary particle interactions classified according to strength of coupling and conserved quantities. The implications of CPT invariance are stated, with C, P, and T defined as operators which transform observables in the usual way. Three classes of theories, proposed to explain the CP violation in K decay, are given. Experimental facts concerning the K^{+}–K^{0} system are presented, and $K^{0}_{L} \rightarrow 2\pi$ without CP violated is tentatively explained. The possibility of strong or electromagnetic violations of CP is examined, along with the η decays which are the most studied process for testing C invariance of the electromagnetic and strong interactions. The neutral K system is reviewed, and the consequences of CPT and CP invariance are assessed. Two models of CP violation are discussed: the superweak model, and models with phase–mismatch. Data on the use of the Weisskopf–Wigner method are included. M.G.J.

N67-40498# Mainz Univ. (West Germany). Institut fuer Anorganische Chemie und Kernchemie.
INDIRECT DETERMINATION OF HALF-LIVES OF SHORT-LIVED FISSION GASES USING A GAS FLOW METHOD
P. Patzelt and G. Herrmann Repr. from Phys. and Chem. of Fission, v. 2, 1965 p 243–252 refs
CFSTI: HC $3.00/MF $0.65

A rate-of-flow method, in combination with an improved charged electrode technique, is used to determine precisely the half-lives of the Kr^{89}, Kr^{93}, Xe^{137}, and Xe^{143} isotopes. With this technique, the radioactive noble gases are swept through a tube by a suitable carrier gas of known constant flow rate. The daughter products of the decaying gases, which are being formed as positively charged recoil atoms, deposit on electrostatically charged electrodes (negative polarity). The daughter activities on

the electrodes decrease exponentially with increasing distance from the uranium target so that from these activities and the linear flow rate of the carrier gas the half-lives of the gaseous precursors may be calculated. Flow rate, irradiation time, cooling period, and counting arrangements are chosen so that measurements of individual daughter products become strongly favored. The half-lives are obtained by extrapolating the appropriate β-decay curves or decay curves of γ-peaks. M.G.J.

N67-40499# United Kingdom Atomic Energy Authority, Harwell (England). Solid State Physics Div.
MULTIPLE ELASTIC SCATTERING OF THERMAL NEUTRONS BY POLYCRYSTALLINE LEAD
G. D. Wignall Jun. 1967 9 p refs
(ARE-M-1911) HMSO: 1s 9d

A comparison is drawn between theory and experiment on multiple elastic scattering of neutrons from polycrystalline solid lead. Measurements were performed on the cold neutron apparatus at the Dido reactor, and details are given on the technique used to obtain appreciable multiple elastic scattering levels which were clearly separable from primary and inelastic scattering processes. The data show that the measured values of the multiple scattering are between 81% and 88% of those predicted by the theory, using a Debye temperature of 81°K. Probable sources of the discrepancy are discussed, and it is concluded that within the approximations involved the formulation of the theory is in good agreement with the observed multiple scattering. M.G.J.

N67-40573# Princeton Univ., N. J. Palmer Physical Lab.
NUCLEAR PHYSICS Annual Progress Report, Apr. 1966–Apr. 1967
R. Sherr Apr. 1967 49 p refs
(Contract AT(30-1)-937)
(PUC-937-260) CFSTI: HC $3.00/MF $0.65

Summaries are presented for experimental and research work being carried out by the following laboratory groups: F. M. cyclotron, atomic beams research, nuclear reaction experiments, nuclear theory, and AVF cyclotron. The atomic beams group continues measurement work on electro-magnetic moments of radioactive nuclei and the theoretical analysis of experimental results. Work on potassium 45 has been completed. In addition to usual experiments with 17.5 MeV protons, the nuclear reactions group is conducting two new experiments: a study of emission of protons from isobaric analog states generated by the (p,n) reaction, and measurement of total proton reaction cross sections by observation of small angle elastic scattering. A technique has been developed to circumvent the problem of slit scattering. The nuclear theory group continues the study of nuclear structure based on the two-body interactions determined from nucleon–nucleon scattering data. The AVF cyclotron has progressed from the design stage to shop fabrication. A listing of 32 papers published by the cyclotron group is included. E.C.

N67-40590 European Organization for Nuclear Research, Geneva (Switzerland).
THE QUARK MODEL OF THE ELEMENTARY PARTICLES
B. T. Feld (MIT) 24 Aug. 1967 52 p refs Lectures given in Geneva, 1967
(CERN-67-21)

The interpretation of hadrons as simple bound states of quarks, using nonrelativistic wave functions is considered in development of a quark model. Three models—those of Fermi–Yang, Sakata, and Schwinger—are discussed as background material. The breakthrough achieved with the work of Gell-Mann and Ne'eman introducing the symmetry group SU_3 is discussed. Next the Sakata model in SU_3 representation is discussed. The quark model is examined with respect to particle representation, the introduction of spin, mass formula for baryons, and mass formula for mesons. Ways of determining the mixing angle from the mass difference are discussed. The quark model in SU_6 is considered as well as applications for nonleptonic decay modes of hyperons, and predictions for the scattering of hadrons. S.P.

N67-40597 Tokyo Univ. of Education (Japan). Dept. of Physics.
CHIRAL DYNAMICS AND TWO PION DECAYS OF CHARGED AND NEUTRAL KAONS
Syurei Iwao [1967] 8 p refs
(TUEP-67-21)

Two pion decay of the charged kaon is re-examined by substituting an additional one meson intermediate state to the current–current form of the effective Lagrangian calculated under a chiral transformation. A condition that this part should vanish in order to keep a good result reported before from a vacuum intermediate state allows us to determine the ratio of the vector form factors f_- and f_+. The value obtained in this way is in good agreement with the experimental one determined from K_{l3} decays. Making use of that ratio and of our effective Lagrangian we can reproduce the $\Delta I = 1/2$ rule and the experimental decay rate of the K_0^1 meson. Author

N67-40598 Tokyo Univ. of Education (Japan). Dept. of Physics.
CHIRAL DYNAMICS FOR PHOTO-HADRON AND WEAK INTERACTIONS
Syurei Iwao [1967] 11 p refs

Chiral dynamics for photo-hadron interaction and weak semi-leptonic decay of baryons is examined in detail. Weinberg's method is naturally extended to the latter problem and leads to the effective Lagrangian containing the four-body semi-leptonic decay of hyperons calculated before by the algebra of currents. The same Langrangian also applies to the semi-leptonic decay of mesons in a proper interpretation of it. A generalization of the method to the hadronic decay of hadrons is straightforward. Author

N67-40600 Tokyo Univ. of Education (Japan). Dept. of Physics.
CHIRAL DYNAMION FOR WEAK HADRONIC DECAY
Syurei Iwao [1967] 13 p refs
(TUEP-67-20)

The Cabibbo current–current type Lagrangian for weak hadronic decay is studied under a chiral transformation. The structure of the Lagrangian thus obtained is examined in connection with hyperon and K meson decays. The two pion decay rate of the charged kaon is estimated numerically and found in a close agreement with the experimental value. Also studied is the neutral current–current type Lagrangian which seems not to be important for the weak interaction. Author

25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

N67-39510*# Michigan Univ., Ann Arbor. Dept. of Aerospace Engineering.
FLUID MECHANICS OF MAGNETICALLY BALANCED ARCS IN CROSS FLOWS Semiannual Progress Report, Apr. 1–Sep. 30, 1967
A. M. Kuethe Sep. 1967 34 p refs
(Grant NGR-23-005-128)
(NASA-CR-89636; Rept.-07912-3-P) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Program progress is summarized on the basis of a study of the fluid mechanics of magnetically balanced arcs in cross flows, spectroscopic investigations of the supersonic air arc, and preliminary design of magnetic field coils. The experimental open jet wind tunnel was completed and is described in detail. In the fluid mechanics study, it is concluded that a range of operating conditions exists for which the steady magnetically balanced arc in a cross flow may be treated as a central impervious core of relatively uniform properties. Within this range the conservation equations for flow of a conducting fluid under equilibrium conditions with negligible Hall effects are valid to a good approximation in the core; the transfer of mass, momentum, and energy to the external flow then takes place through a relatively thin boundary layer. Spectroscopic studies of the supersonic balanced arc indicate that, under some as yet unclear circumstances, sodium and copper atom lines are present in the column. E.C.

N67-39527# Texas Univ., Austin. Plasma Dynamics Research Lab.
RESEARCH ON PLASMA DIAGNOSTIC METHODS FOR HIGH TEMPERATURE PLASMA RESEARCH Final Report, 1 Apr. 1965–31 Dec. 1966
Arwin A. Dougal, Otto M. Friedrich, Jr., M. O. Hagler, D. J. Mayhall, H. N. Roberts et al Wright-Patterson AFB, Ohio, ARL, Mar. 1967 121 p refs
(Contract AF 33(615)-3124)
(ARL-67-0062; AD-658052)

A new experimental arrangement of the infrared maser-interferometer detector combination employed to investigate dynamical gaseous plasmas and narrow, rapidly moving cylindrical detached shocks in a 30 kilojoule theta pinch was conceived, fabricated, and tested. This maser-interferometer-detector system has markedly improved frequency response. Because of its usefulness in determining the electron density from laser interferometry data, an expression for the laser resonator energy density as a function of the second resonator length was derived, under the assumption of dielectric mirrors. A Fabry-Perot interferometer in which the plane mirrors of infinite extent are prefaced by Brewster windows, and plane electromagnetic waves propagate along the z-axis through a lasing medium immersed in a steady state magnetic field was considered. The effect of the magnetic field on resonator tuning, on critical gain requirements, and on the polarization of the laser output beam were investigated. The advent of the giant pulse ruby laser as an extremely powerful energy source has provided the plasma researcher with a means of producing ultra-pure plasmas in which electron densities may range as high as 10 to the 21st power electrons/cc. A giant pulse ruby laser illuminated Mach-Zehnder interferometer is employed to study laser induced discharges in air at atmospheric pressure. Strong blast wave theory was employed to investigate the dynamics of gaseous plasmas produced when a giant pulse ruby laser was focused in gases initially at 1-2000 atmospheres. TAB

N67-39554# Innsbruck Univ. (Austria). Inst. for Theoretical Physics.
STABILITY OF HELMHOLTZ PLASMA FLOW IN A DISCONTINUOUS MAGNETIC FIELD
Franz Herrnegger 27 Jun. 1967 12 p refs
(Contract F61052-67-C-0014)
(AFOSR-67-2066; SR-47; AD-658044)

An investigation is made of linear stability effects of time dependent plasma flow of Helmholtz type in a discontinuous magnetic field by means of Laplace transforms. The stabilities arise because of a tangential discontinuity of velocities between two streams of a homogeneous, nondissipative, incompressible, isotropic plasma. The plasma is characterised by a negative Richardson number and constant Alfven velocity which has a jump at the interface. Author (TAB)

N67-39555# Innsbruck Univ. (Austria). Inst. for Theoretical Physics.
THEORETICAL ANALYSIS OF A COAXIAL HALL ACCELERATOR
K. Lackner 6 Mar. 1967 21 p refs
(Contract F61052-67-C-0014)
(AFOSR-67-2073; SR-45; AD-658045)

The coaxial Hall current accelerator is investigated theoretically taking account of ion slip, variable electrical conductivity and variable magnetic field strength. The operating regimes are outlined and closed analytical solution is given for the axial variation of the flow parameters. Author (TAB)

N67-39587*# Harvard Coll. Observatory, Cambridge, Mass. Shock Tube Spectroscopy Lab.
THE INDEX OF REFRACTION IN THE NEIGHBOURHOOD OF AN ISOLATED STARK BROADENED SPECTRAL LINE
Richard A. Day Aug. 1967 20 p refs
(Grant NsG-438)
(NASA-CR-89560; SR-20) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The index of refraction in the neighbourhood of a Stark broadened spectral line has been calculated using the Kronig–Kramers relation between the absorption coefficient and the index of refraction. For the absorption coefficient, the function $j_r(x,\alpha)$ given by Griem has been used. A discussion of the results as they apply to the hook method of measuring oscillator strengths is given, and it is shown that errors of the order of 5% can occur in the oscillator strength if the conventional formula for anomalous dispersion is used. Author

N67-39618# Army Electronics Labs., Fort Monmouth, N. J.
DESCRIPTION OF AXISYMMETRIC WAVE PROPAGATION IN A UNIFORM, FINITE, SOLID ELECTRON BEAM
Bruno Zotter Jul. 1967 29 p refs
(ECOM-2868; AD-658987)

The slow-wave approximation is used to derive the dispersion relation for a uniform, finite, solid electron beam in a concentric tunnel. A finite, longitudinal magnetic field is used to focus the beam. Radial and longitudinal propagation constants are computed for modes with axial symmetry. The propagation constants and the plasma frequency reduction factor are presented in a novel, graphical form which allows construction of the Brillouin diagram in a simple straightforward way. A number of representative Brillouin diagrams are shown, and the modes are classified in accordance with their characteristics. Author (TAB)

N67-39648# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.
BASIC PLASMA PROCESSES Yearly Summary Technical Report, 16 Nov. 1965–30 Jun. 1967

A. V. Phelps and C. L. Chen 30 Jun. 1967 37 p refs
(Contract Nonr-4725(00))
(AD-657864)

An experimental study of the self-broadening of cesium resonance lines was made using measurements of the transmission of white light through a cell filled with Cs. Discrepancies between previous results were resolved in favor of the older results of Gregory. It was found that recent investigators have not taken proper account of the transmission characteristics of the monochromator used in the measurements. The understanding of the role of the monochromator makes available an additional technique for the measurement of cesium and other metal vapors in power conversion devices. The results of exploratory measurements of the scattering of resonance radiation are discussed. Author (TAB)

N67-39674# Princeton Univ., N. J. Plasma Physics Lab.
A DIGITAL COMPUTER PROGRAM FOR COMPUTING ION SATURATION CURRENTS FROM A PLASMA OF UNIFORM DENSITY IN A TWO-DIMENSIONAL GEOMETRY
John L. Harrison Aug. 1967 42 p refs
(Contract AT(30-1)-1238)
(MATT-551) CFSTI: HC $3.00/MF $0.65

The shape of the surface from which ions are extracted is a major factor in determining the tractability of an ion beam for fine focusing. In duoplasmatron-type ion sources the extraction is made from a plasma, and the shape of the plasma surface has been difficult to define. A computer program is described which both determines the shape of plasma surface in a known extraction geometry with known current density at the surface and calculates trajectories of particles leaving this surface. Author (NSA)

N67-39684# California Univ., Livermore. Lawrence Radiation Lab.
QUANTUM MECHANICAL TREATMENT OF STATIC TRANSPORT PHENOMENA IN NON-DEGENERATE PLASMAS
Robert H. Williams (Ph.D. Thesis—Calif. Univ., Berkeley) 3 Feb. 1967 172 p refs
(Contract W-7405-ENG-48)
(UCRL-50166) CFSTI: HC $3.00/MF $0.65

A convergent kinetic equation for a nondegenerate electron gas is derived from the quantum mechanical BBGKY hierarchy for the Wigner distribution functions. When the two-particle interaction is split into a strong, short-range part plus a weak long-range part, a Boltzmann-like kinetic equation is obtained in which the cross section is a sum of three terms: an exact binary collision cross section for the short-range part of the interaction, plus a Born approximation cross section for the dynamically screened long-range part of the interaction, plus a cross correlation cross section evaluated in the Born approximation. In the cross correlation term, the effects of the long- and short-range parts of the interaction are mixed. After the kinetic equation is generalized to a fully ionized plasma, the kinetic equations are solved using the Chapman–Enskog technique. General expressions are obtained for the static transport coefficients in terms of the Chapman–Cowling bracket expressions. Among the quantities evaluated are the transport cross sections for the short-range part of the interaction. Exchange effects are also considered. Author (NSA)

N67-39734# Aerospace Corp., El Segundo, Calif. Aerodynamics and Propulsion Lab.
MICROWAVE BREAKDOWN OF THE REENTRY BOUNDARY LAYER
W. Paul Thompson, Melvin Epstein, and Carl J. Lenander May 1967 30 p refs
(Contract AF 04(695)-1001)
(TR-1001(2240-20)-11; SSD-TR-67-95; AD-658851)

Measurements of the microwave power required for breakdown were made in a simulated reentry boundary layer flow. By establishing a fully developed laminar pipe flow between cold walls, fed by a subsonic arc jet, a simulation was made of the appropriate boundary layer temperature, density, electron concentration, and chemical composition profiles over an altitude range from 80 to 180 kft. Correlation with existing theoretical models and comparison with recent hot-air breakdown measurements in shock tubes are made. The effects of chemical composition of hot air and of typical ablation products and quenchants upon breakdown are briefly explored. It is found that significant reduction in breakdown power occurs in hot air flows and that present theoretical models do not predict the high altitude breakdown power within a factor of three or more. Author (TAB)

N67-39757*# Illinois Univ., Urbana. Electrical Engineering Research Lab.
GENERALIZED STOCHASTIC EQUATIONS AND THEIR APPLICATIONS TO PLASMAS
Kam-Chuen So Sep. 1967 94 p refs
(Grant NsG-24)
(NASA-CR-89623; TR-31) CFSTI: HC $3.00/MF $0.65 CSCL 20I

A new formulation of the Fokker–Planck method is established to describe the distribution of a particle in a random field. The coefficients actually involve conditional averages of functionals of the random field. As a Fokker–Planck equation can be used to describe the lowest distribution, similar equations can also be used to describe higher distributions. Such a set of equations is applicable to systems perturbed by small random forces. When the forces are specified statistically, the generalized stochastic equations give immediate results. Of particular interest is the electron heating by random electric fields. For the Coulomb potential problem in which the electric field has to be determined consistently, it is possible to decouple the set of generalized equations by using a cluster expansion. Results indicate that the use of a Vlasov equation in finding the polarization effect is essentially justified and the effect is seen to be the consequence of the condition imposed on the average in evaluating the coefficient. Finally, a similarity is observed between the set of generalized stochastic equations and the BBGKY hierarchy, and the BBGKY hierarchy may be regarded as a special mode of generalized stochastic equations. Author

N67-39770 Institut für Plasmaphysik G.m.b.H., Garching (West Germany).
ON THE POSSIBILITY OF MEASURING MAGNETIC FIELDS BY SCATTERED LIGHT
G. Lehner and F. Pohl Aug. 1967 18 p refs
(IPP-1/69)

In the following report we discuss the possibility of measuring magnetic fields by scattered light. In the case of uncorrelated electrons the electron spectrum is modulated with the electron gyration frequency if a certain condition is fulfilled. The essential parameters are discussed and some spectra are computed numerically. Author

N67-39778# Aerospace Corp., El Segundo, Calif. Plasma Research Lab.
LABORATORY SIMULATION OF REENTRY PLASMA SHEATHS
Gordon E. Stewart Apr. 1967 11 p refs
(Contract AF 04(695)-1001)
(TR-1001(2220-10)-6; SSD-TR-67-144; AD-658882)

A technique was developed for simulating in the laboratory the electronic properties of reentry plasma sheaths using a novel

type of discharge. This technique can be used to cover a metallic model of a reentry vehicle of almost any shape with a plasma layer. Unlike the conventional simulation methods using electrical discharges, glass walls are not needed to confine the discharge, and therefore pattern distortion is minimized. The plasma produced has an electron-density profile very similar to that found in the viscous boundary layer of a reentering vehicle. Author (TAB)

N67-39779*# Catholic Univ. of America, Washington, D. C. Dept. of Space Science and Applied Physics.

DIAGNOSTICS OF ACCELERATING PLASMA Semiannual Progress Report, 1 Mar.–31 Aug. 1967

T. N. Lie, A. W. Ali, and C. C. Chang 31 Aug. 1967 32 p refs

(Grant NGR-09-005-025)

(NASA-CR-89796; Rept.-67-029; SAPR-3) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The electric polarity effect observed in the coaxial plasma accelerator has no convincing explanation so far. A possible mechanism for the unexpected behavior of the current-sheet with some experimental evidences is examined. A considerable level of pre-ionization, a discharge current ahead of the current-sheet, and an axial current along the anode surface were observed in both parallel plate and coaxial plasma accelerators. The polarity effect in the coaxial accelerator is not likely due to a hydromagnetic origin but is inferred to be primarily a discharge phenomena caused by unusually high anode sheath voltage and lower cathode fall within a current-sheet. The current-sheet produced with the hydrogen filling behaves differently from non-hydrogen gas filling as was shown in a previous report and this is explained with the proposed mechanism. The calculation of partition functions of He II and C II was carried out as a preliminary study of radiation loss and the result is shown. Author

N67-39841# RCA Victor Co., Ltd., Montreal (Quebec).

NONLINEAR MIXING OF WAVES IN A PLASMA WITH VELOCITY-DEPENDENT COLLISIONS

Issie P. Shkarofsky Wright-Patterson AFB, Ohio, ARL, May 1967 41 p refs

(Contract AF 33(615)-2196)

(ARL-67-0102; RR-7-801-56; AD-657774)

The frequency difference, sum and second harmonic currents, due to two interacting waves in a plasma with no external magnetic field, are calculated. The oscillation frequencies are taken to be sufficiently high that ion motion can be neglected. Landau damping is negligible compared to collisional damping. The nonlinearity is due to gradients in the a-c electric fields. The form of the zero order isotropic and non-oscillatory part of the velocity distribution function is left arbitrary. The velocity dependences of the collision frequency of electrons with neutrals, ions and other electrons are properly accounted for. The Fokker-Planck equation in its integro-differential form and including nonlinear terms is used for electron-electron collisions. The self-consistent electric field is included with nonlinear terms. Results are given (a) for any degree of ionization provided the lowest frequency in the mixing process is greater than the total collision frequency and (b) for a slightly ionized gas for any ratio of oscillation to collision frequency. In the former case, it is shown that electron-electron effects do not contribute to the nonlinear current arising from wave-mixing but contribute to the nonlinear self-consistent electric field. Author (TAB)

N67-39844# Aeronautical Research Associates of Princeton, Inc., N. J.

ON THE EVOLUTION OF THE PROBABILITY DISTRIBUTIONS AND OF THE CORRELATION FUNCTIONS IN A BOGOLUBOV PLASMA

A. Fritz, S. Radin, and G. Sandri Wright-Patterson AFB, Ohio, ARL, May 1967 42 p refs

(Contract AF 33(615)-1910)

(ARL-67-0103; AD-657773)

Recently a matrix formulation of nonequilibrium statistical mechanics was developed and applied to dilute gases and to small momentum transfer interactions. The paper shows that the matrix formulation of the nonequilibrium equations can be extended to the Bogolubov gas. The asymptotic behavior is calculated for times long compared with the plasma frequency for: (1) the probability distribution functions, and (2) the Mayer correlation functions. The collision integrals that determine the higher order kinetic equations for the Bogolubov gas are thereby constructed. The calculations performed directly with the nonlinearly-coupled Mayer functions are shown to be equivalent to those performed with the linearly-coupled probability distribution functions. In lowest order the theory coincides with a result obtained previously by Bogolubov. Author (TAB)

N67-39852# Aeronautical Research Associates of Princeton, Inc., N. Y.

THE KINETIC THEORY OF A PLASMA IN THE PRESENCE OF STRONG MAGNETIC FIELDS. I: GENERAL THEORY

S. Radin, Arnold H. Kritz, and G. Sandri Wright-Patterson AFB, Ohio, ARL, Jul. 1967 35 p refs

(Contract AF 33(615)-1910)

(ARL-67-1150; AD-658460)

We obtain, from the BBGKY hierarchy of equations, the kinetic equation for the single-particle electron distribution function for a plasma in a strong magnetic field. The derivation is carried out by means of the method of extension developed previously. It is applicable to magnetic flux densities of strength up to 0.003(the square root of (n/cc)) gauss (where n is the electron number density), a situation often occurring in laboratory and astrophysical plasmas. The kinetic equation describes weakly inhomogeneous and nongyrotrophic plasmas in the Landau (small momentum transfer) approximation. Author (TAB)

N67-39853*# Catholic Univ. of America, Washington, D. C. Dept. of Space Science and Applied Physics.

STRUCTURE OF MAGNETOHYDRODYNAMIC SHOCK WAVE

Chung Kung Liu Jun. 1967 67 p refs

(Grant NGR-09-005-(025))

(NASA-CR-89624; Rept.-67-028) CFSTI: HC $3.00/MF $0.65 CSCL 20I

This dissertation studies the structure of the plane magnetohydrodynamic shock wave of a rarefied, fully-ionized plasma. Both the shock front and the magnetic field are assumed to be perpendicular to the flow direction. In the undisturbed region, the gas pressure (=nkT) can be comparable to, much smaller or much larger than the magnetic pressure ($=B^2/8\pi$), and also the magnetohydrodynamic Mach number (M^*) can be any value greater than unity. Since the plasma is so rarefied that the mean-free-path here cannot be considered as a relevant scale length for the shock thickness, instead the geometrical mean of the ion and electron Larmor radius is the appropriate one. Under these assumptions, the structure of larger M^* shock wave is solitary wave-like, and that of smaller M^* shock wave can be either oscillatory or monotonic depending on the value of electrical resistivity. Author

N67-39907# Alberta Univ., Edmonton. Dept. of Physics.

WAVE–WAVE INTERACTION BETWEEN TRANSVERSE PLASMA OSCILLATIONS

Som Krishan Mar. 1967 12 p refs
(Contract Nonr-4072(00))
(AD-658738)

The non-linear wave-wave interaction between parallel transverse plasma waves is studied in terms of emission and absorption of plasmons. In the collective oscillation limit (k sq.) < (omega-p sq.)/(c sq.), the parallel waves do not interact. Author (TAB)

N67-39931# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
PRELIMINARY TEMPERATURE MEASUREMENTS BEHIND STRONG SHOCK WAVES IN ARGON
A. Levy Sep. 1967 63 p
(Grant AF-AFOSR-365-66)
(UTIAS-119; AFOSR-67-1579) CFSTI: $3.00

The need for temperature measurement in strong shock waves is discussed briefly and requirements for a suitable experimental method are established. Spectrometric methods are shown to be appropriate and the relative line intensity technique is discussed. Experiments using photography for both time-integrated and time-resolved exploration of the argon emission spectrum in a M_s=11.3, p_1=3 torr shock are described. The results were used in the main series of experiments, which gave time-resolved records from photo-multipliers monitoring the intensities of selected neutral argon lines. These records are analyzed, including self-absorption correction, to a time-resolved excitation temperature profile for the neutral argon atoms. The probable uncertainty in these measurements is computed and the shape of the temperature profile is discussed. The conclusions are that the atom excitation temperature rises to an approximately constant value of about 11,500°K behind the shock front, which is in fair agreement with the calculated equilibrium value, but that uncertainties were too great to allow, for example, cooling calculations based on the shape of the temperature profile. Experimental improvements are suggested to reduce uncertainties and allow detailed analysis in future work. Author

N67-39998 Institut für Plasmaphysik G.m.b.H., Garching (West Germany).
NONLINEAR INTERACTION BETWEEN ELECTROACOUSTIC AND TEM WAVES AT MICROWAVE FREQUENCIES
B. B. O'Brien, Jr. Jun. 1967 21 p refs
(IPP-3/54)

Measurements of mixing (nonlinear interaction) of two low level microwave signals in an isotropic positive column are described. One signal (650 MHz) excites a propagating electroacoustic wave. The other signal (1150 MHz) propagating along a TEM line interacts with the plasma wave to produce signals with the sum and difference frequencies. The amplitudes of the scattered signals are in reasonable agreement with the values predicted by a simple theory involving an equivalent dielectric constant. Author

N67-40003 Nagoya Univ. (Japan). Inst. of Plasma Physics.
EXPERIMENTAL STUDY OF ELECTROSTATIC ION CYCLOTRON WAVES IN THE PLASMA
Teruyuki Sato, Kiyokata Matsuura, Akira Miyahara, and Shigeo Nagao Aug. 1967 78 p refs
(IPPJ-58)

Resonance peaks observed near the ion cyclotron harmonics (n ≤ 5) of H^+, H_2^+ and H_3^+ are studied in a low density plasma column. According to the dependence on rf voltage applied across a plasma column and electron temperature of the resonance frequency, it is considered that the behaviour of these resonances is caused by the electrostatic ion cyclotron waves propagating almost perpendicular to the magnetic field. Ions collected by ion collectors and electrodes are accelerated perpendicularly up to 3 keV, while the electron temperature displays little increase. The observed plasma loading indicates that the efficiency of power transfer between the electrodes and the plasma is greater than 50%. Author

N67-40013# Case Inst. of Tech., Cleveland, Ohio.
PROPAGATION IN WAVEGUIDES FILLED WITH WARM PLASMA
Philip W. Nield Jun. 1967 186 p refs
(Contract AF 19(628)-1699)
(SR-16; AFCRL-67-0419; AD-658828)

The linearized equations describing the propagation of the normal modes in a plasma filled waveguide at microwave frequencies and in the presence of an axial constant magnetic field are derived from moments of the Boltzmann equation. Collisions are retained. For two cases where the plasma is assumed to be drifting but uniform or stationary but non-uniform in the transverse plane it is possible to completely solve for the fields by solving a set of coupled equations for the axial electric and magnetic fields and the pressure. If the plasma is assumed to be stationary and uniform these reduce to a set of coupled Helmholtz equations. Solutions for this case are considered in detail. The equations can be simplified considerably and cast into a form very similar to those used to describe wave propagation in a cold plasma. Solutions are obtained by employing an iterative technique. Author (TAB)

N67-40059*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A COMPUTERIZED DATA-REDUCTION TECHNIQUE FOR LANGMUIR PROBE ANALYSIS OF ELECTRON TEMPERATURE VARIATIONS IN THE EXHAUST OF A MAGNETOPLASMADYNAMIC ARC
David R. Brooks and James M. Hoell, Jr. Washington, NASA, Nov. 1967 24 p refs
(NASA-TN-D-4220) CFSTI: HC $3.00/MF $0.65 CSCL 20I

A computerized technique is described whereby Langmuir probes may be used effectively to obtain detailed local measurements of electron temperature in the plasma beam produced to a 5- to 10-kW magnetoplasmadynamic accelerator. To achieve the necessary spatial resolution, on the order of 1000 values of electron temperature must be obtained for each operating condition of the accelerator. A 60-Hz probe-driving voltage and an automatic data-reduction system are used to obtain and analyze Langmuir probe characteristics. Accurate position correlation is provided by a specially designed probe driver. Probe curves and position information are recorded on FM tape and digitized for processing on the Langley IBM 7040–7094 DCS computer system. Author

N67-40109*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL INVESTIGATION OF A VARIABLE-LENGTH CONSTANT-VELOCITY TRAVELING MAGNETIC WAVE PLASMA ACCELERATOR
Raymond W. Palmer and Robert E. Jones Washington, NASA, Oct. 1967 21 p refs
(NASA-TN-D-4208) CFSTI: HC $3.00/MF $0.65 CSCL 20G

A study was conducted to experimentally determine the optimum length for the traveling magnetic wave plasma accelerator that maximizes the kinetic efficiency. The accelerator kinetic efficiency, taken from thrust measurements, was determined for accelerators of various lengths. The effective accelerator length could be changed by adjusting the axial position of the propellant injector fitted into an 8-coil accelerator. The kinetic efficiency measurements showed that the optimum accelerator length is 1/4 wavelength for argon propellant and 1 wavelength for xenon propellant. For

accelerator lengths less than 1/4 wavelength, the discharge could not be started. Emitting-probe data for argon propellant show that over a limited range (3/4 to 1 wavelength) the plasma potential difference between entrance and exit is capable of accelerating argon ions to a specific impulse higher than that measured with the thrust drum. At all other accelerator lengths, however, the potentials were too low to generate ion velocities corresponding to the measured values of specific impulse. These low values could not be explained. The degree of penetration of the magnetic wave into the plasma was measured with a magnetic probe. Only minor changes in the amplitude and phase angle of the magnetic field were noted between the no-plasma and plasma conditions. The effect of a direct-current magnetic nozzle on accelerator performance is reported. The interaction between the nozzle magnetic field and the plasma stream acted to reduce the accelerator kinetic efficiency by reducing the thrust. Author

N67-40122*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.

REVIEW OF HIGH-FREQUENCY RADIOWAVE DUCTING IN THE MAGNETOSPHERE OF THE EARTH

J. Ramasastry Washington, NASA, Oct. 1967 27 p refs

(NASA-TM-X-1457) CFSTI: HC$3.00/MF$0.65 CSCL 04A

This memorandum is intended to provide a basis as for any further theoretical or experimental work on HF radiowave ducting phenomenon in the magnetosphere of the Earth. Past theoretical work and observational evidence on ducting is reviewed. The justification for field-aligned ionization structures is discussed in the light of previous observations and conclusions. Previous HF experiments aimed at verifying the existence of ducts and shells in the magnetosphere are reviewed and possible causes of their failure are indicated. Similar information obtainable through VLF investigations is described and a comparison is made between the HF ducting techniques and the VLF techniques. Available ray-tracing programs are discussed from the point of view of deriving the experimental parameters and the propagation characteristics of guided HF radiowaves. A few of the magnetospheric phenomena which may be investigated by using HF duct propagation techniques are discussed. Author

N67-40138*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

OPERATION OF AN ION-CYCLOTRON-WAVE GENERATION APPARATUS IN A RF SELF-SUSTAINED MODE

Clyde C. Swett, Roman Krawec, and Henry J. Hettel Washington, NASA, 1967 15 p refs Presented at the 9th Ann. Meeting of the Plasma Phys. Div. of the Am. Phys. Soc., Austin, Tex., 8–11 Nov. 1967

(NASA-TM-X-52365) CFSTI: HC$3.00/MF$0.65 CSCL 20G

At rf power levels above 19 kw, a hydrogen plasma of average electron density 1 to 2×10^{12} cm^{-3} was produced continuously by an electrostatically shielded Stix coil. This rf self-sustained mode is possible over a very limited range of magnetic fields ($0.934\leq\Omega\leq0.958$, where Ω is the driving frequency divided by the ion-cyclotron frequency), and at a neutral gas pressure of 2.5 microns. Over the range of magnetic fields, the power input to the plasma remains constant for a constant coil current. Magnetic probe measurements indicate a plasma wave having a wavelength approximately equal to that of the rf coil. Some discrepancies between theory and experiment are noted in phases and amplitudes of the probe signals. The wave attenuates rapidly in the uniform field region just outside of the coil, losing most of its amplitude in about one-half wavelength. Probe signals exhibited strong amplitude modulation with components in the 10–100 kc range. Some evidence of wave reflections is noted. Author

N67-40167# Bureau of Mines, Morgantown, W. Va.

NEW CONCEPT OF ELECTRON DETACHMENT FOR AIR IN NEGATIVE CORONA AT HIGH TEMPERATURE

C. C. Shale Nov. 1967 15 p refs

(BM-IC-8353)

Current-voltage relationships for air at high temperature in negative corona are compared with relationships predicted by theory. Deviations are discussed. Based on the latest theoretical concept of electron detachment from negative ions and recent findings in basic research on free electron gases, results of applied research show the existence of free electrons in air at high temperature and high field strength-to-pressure ratios. Author

N67-40178# Aerospace Research Labs., Wright-Patterson AFB, Ohio.

ELECTRIC ARC DISCHARGES IN TRANSVERSE MAGNETIC FIELDS, PART I

Herbert O. Schrade Jun. 1967 115 p refs

(ARL-67-0119; AD-658459)

The dynamic behavior of electric arc discharge columns, which are subjected to transverse external magnetic fields, was studied through an analysis of all the forces acting normal to a segment of the arc column. This analysis led to an explanation of magnetic arc pumping which was found to be the cause of arc retrograde motion as well as the discontinuous motion of electrode attachment points. It is shown that a gasdynamic force is generated through the combined action of the self-induced magnetic field of a current-carrying plasma and of a superimposed external magnetic field. This force opposes the Lorentz force generated by the external field; it is the reaction force of a hydromagnetically induced transverse gas flow which is generated within the current-carrying channel. Arc pumping and associated phenomena may also occur in the absence of an external magnetic field if the arc column is curved. This is explained by the fact that the distribution of Lorentz forces on a curved arc column is comparable to that on a straight arc column in a transverse magnetic field. Author (TAB)

N67-40179# General Electric Co., Philadelphia, Pa. Space Sciences Lab.

RF-INDUCED PLASMA SHIELD PROPAGATION IN RARE GASES Scientific Report

George W. Bethke and A. D. Ruess Bedford, Mass., AFCRL, Aug. 1967 80 p refs

(Contract AF 19(628)-4382)

(AFCRL-67-0491; SR-1; AD-658868)

It has been observed that microwave irradiation of localized weak ionization in heavy rare gases can cause an ionization wave to form and propagate towards the rf source. This ionization wave is preceded by an electron precursor, with the electron density at the ionization wave front increasing very rapidly to a maximum followed by a relatively slow plasma decay. At rf power levels well below normal breakdown, the ionization wave will form and then propagate at velocities from about 2,000 cm/second over 1,000,000 cm/second. Discontinuous changes of ionization wave velocities with changes in rf power and gas pressure indicate the existence of three different velocity-controlling mechanisms in the gas pressure and rf power ranges investigated. These mechanisms for ionization wave formation and propagation have been investigated in xenon, krypton, and argon gases, and are discussed. Author (TAB)

N67-40188* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

SHOCK WAVE STRUCTURE IN RECOMBINING LOW-DENSITY PLASMAS

Walter H. Christiansen [1965] 8 p refs

(Contract NAS7-100)

(NASA-CR-89743) CSCL 20I

Electron density and temperature distributions were measured in front of a flat disk in cesium-seeded argon gas plasma to examine the case where thermal diffusion is a dominant feature in a nonequilibrium plasma flow; and results are presented. The experiment was carried out at a Mach number of 5.1 with a free stream number density of electrons from $4\times10^{11}/cm^3$ to $1.8\times10^{12}/cm^3$ and with an electron temperature between 0.058 ev to 0.12 ev. The region of interest extended several body diameters upstream of the disk and through the heavy particle shock. The background pressure of the neutral argon gas was set at a fixed level of 100μ Hg, which together with the ionized cesium represents a degree of ionization from 10^{-4} to 4×10^{-4}. The plasma recombining under the above conditions (even through the shock wave) was quite luminous. Free molecule Langmuir probes showed very little change in ion or electron density ahead of the shock wave, in close accordance with spectroscopic observations. L.S.

N67-40199* International Information, Inc., Philadelphia, Pa.
STATISTICAL ACCELERATION OF PARTICLES IN TURBULENT PLASMA [STATICHESKOYE USKORENIYE V TURBULENTNOY PLAZME]
V. N. Tsytovich Washington, NASA, Dec. 1966 90 p refs Transl. into ENGLISH from Usp. Fiz. Nauk (Moscow), v. 89, no. 1, 1966
(Contract NASw-1499)
(NASA-TT-F-10460) CSCL 20I

A review is made of the progress of the theory of statistical mechanisms of acceleration, resulting from the development of the theory of a weakly-turbulent plasma. A discussion follows on the various applications related to astrophysical problems as well as the possible interpretations of many laboratory experiments. The general characteristics of statistical acceleration considered in detail require the reader to have only a general knowledge of methods of statistical physics. Potential application of accelerating mechanisms in contemporary problems of the physics of turbulent plasma are also discussed. Author

N67-40222*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
CORRELATION MEASUREMENTS OF PLASMA FLUCTUATIONS IN A HALL CURRENT ACCELERATOR
John S. Serafini Washington, NASA, 1967 16 p refs Presented at the 9th Ann. Meeting of the Plasma Phys. Div. of the Am. Phys. Soc., Austin, Tex., 8–11 Nov. 1967
(NASA-TM-X-52366) CFSTI: HC$3.00/MF$0.65 CSCL 20G

Correlation measurements have been made in an annular Hall-current plasma accelerator having an axial electric field, a radial magnetic field and a slightly-ionized, low-current and low-pressure argon discharge. The fluctuations are measured using electrostatic probes. Measurements of the r.m.s. amplitudes, amplitude spectra, and the space–time correlations of the fluctuations have been made with a correlation analyzer having a response up to 500 kHz. Results are presented and discussed for two typical discharges having different ratios of coherent low-frequency fluctuations (due to azimuthal rotation) to "non-coherent" fluctuations. Frequency filtering of the probe signals was used to study the coherent fluctuations separately from the "non-coherent" fluctuations. Comparison of the results for floating, ion-collecting and electron-collecting conditions of the probe permits some inferences to be drawn regarding the nature of the fluctuations. Author

N67-40223*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
RADIO-FREQUENCY INDUCTION HEATING OF LOW-PRESSURE PLASMAS
Ronald J. Sovie and George R. Seikel Washington, NASA, Oct. 1967 61 p refs
(NASA-TN-D-4206) CFSTI: HC$3.00/MF$0.65 CSCL 20I

Induction heating of a low-density cylindrical plasma is investigated experimentally and analytically; in particular, the ohmic power dissipation and energy storage in the plasma are studied. The experimental values for both quantities are in good agreement with the theoretical results. The theoretical treatment consists of a linearized analysis of the coupling of a solenoidal radio-frequency magnetic field and a steady cylindrical plasma. The plasma is assumed to have uniform electron density, electron temperature, and resistivity. An interesting result of this analysis is that for low pressure plasmas this inductance change is a function of electron density only. The experiments were conducted in helium at pressures of 3 to 20 microns with a 17.5-megahertz, 2-kilowatt radio-frequency power supply. The power dissipated, the average energy stored in the plasma, and the radio-frequency magnetic field were determined from detailed electrical circuit measurements. To compare theory and experiment, line ratio spectroscopy and microwave interferometry were used to determine the electron temperature and density, respectively. Power transfer efficiencies as high as 73 percent were obtained with 650 watts being coupled to the plasma. Author

N67-40304# RAND Corp., Santa Monica, Calif.
A MODEL FOR THE GENERATION OF MAGNETO AND HYDRODYNAMIC WAVES BY HIGH-ALTITUDE NUCLEAR BURSTS
R. F. Lutomirski Aug. 1967 55 p refs
(Contract DAHC15-67-C-0141; ARPA Order 189-1)
(RM-5301-ARPA; AD-658716)

A model for the generation of magnetohydrodynamic waves by high-altitude nuclear bursts is presented which approximates the physical conditions present immediately following the detonation of a nuclear device. This model of the debris expanding into the upper ionosphere-exosphere is taken to be a conducting sphere expanding at a constant velocity into a magnetoplasma, pushing the magnetic field aside and then abruptly stopping. It is found that the system does exhibit hydromagnetic radiation, which is calculated, and that this radiation can in some cases be much less than the hydromagnetic yield of the device. For a given device, the radiation depends strongly on the local value of the Alfven speed at the burst altitude. Author (TAB)

N67-40306* Illinois Univ., Urbana. Aeronomy Lab.
PLASMA PROBE STUDIES
K. G. Balmain 1 May 1966 100 p refs *Its* Aeronomy Report No. 11
(Grant NsG-511; Contract AF 19(628)-3900)
(NASA-CR-89781) CSCL 20I

Problems relating to RF and DC probes in plasma media are studied with emphasis on the ionospheric plasma. The radio frequency impedance of a plasma probe is examined for the case of a collapsed ion sheath resulting from the application of positive DC bias. With sheath collapse the electron density in the plasma is approximately uniform but electrons are continually absorbed into the metal surface of the probe. A quasi-static theory is used to obtain a formula for the impedance of a small spherical electrode in a cold magnetized plasma. The derivation allows for the presence of an ion sheath represented by a free-space gap between the probe and the surrounding plasma. The problem of a narrow slot antenna in a perfectly conducting rigid metal plane immersed in a compressible plasma is also considered. Expressions are derived for the far fields that consist of an electromagnetic space wave, an electroacoustic space wave, and a surface wave. A study is made of ion collection at high gas pressure by a spherical DC probe. It is assumed in the theoretical development that the ion

drift velocity is proportional to the electric field strength raised to an arbitrary power. The theoretical current–voltage characteristic is used to obtain an ion density profile for a pre-sunrise rocket shot into the lower ionosphere. Finally suggestions are made for future experimental probe studies that can be carried out with the aid of ionospheric rockets. S.P.

N67-40327* International Information, Inc., Philadelphia, Pa.
A STUDY OF THE CURRENT DENSITY DISTRIBUTION IN A HOMOPOLAR CELL [IZUCHENIYE RASPREDELENIYA PLOTNOSTI TOKA V GOMOPOLYARNIKE]
E. M. Drobyshevskiy and S. I. Rozov Washington, NASA, Dec. 1966 18 p refs Transl. into ENGLISH from Zh. Tekhn. Fiz. (Leningrad), v. 36, no. 7, 1966 p 1186–1197
(Contract NASw-1799)
(NASA-TT-F-10674) CSCL 20I

Using plane probes located on the surface of the external electrode, the current density distribution of the radial current was investigated in a homopolar cell. It was found that two main factors affect the current density distribution in the volume: the deviation of the magnetic field from perpendicularity to the electric field and the nature of current density distribution on the anode. The effect of the first factor increases with increase of the density of the gas. Current density distribution on the anode, in turn, depends on the mutual configuraton of the magnetic field and the surface of the anode. It was found that defocusing of the discharge takes place. From the nature of current density distribution in the volume of the homopolar cell evaluation of temperature of the ionic component was made. Author

N67-40378# New Mexico State Univ., Las Cruces.
A SOLUTION OF THE TRANSIENT MAGNETOHYDRODYNAMIC COUETTE FLOW
Michel Charles (M.S. Thesis) Aug. 1967 66 p refs Sponsored by NAS and ESRO
CFSTI: HC $3.00/MF $0.65

A solution to the differential equations of the transient hydrodynamic Couette flow of an incompressible fluid is presented. The wall velocity is treated as an arbitrary function of time. The finite transform method is used to obtain this solution. Two examples are presented: impulsive starting of the wall and wall velocity proportional to $(1-e^{-at})$. Comparison of the particular solutions represented by these examples to solutions obtained directly by other authors show the results to be similar. Author (ESRO)

N67-40392 Institut für Plasmaphysik G.m.b.H., Garching (West Germany).
INVESTIGATION ON THE ANISOTROPY AND RELAXATION OF THE PLASMA IN THE ISAR I MEGAJOULE THETA PINCH [UNTERSUCHUNGEN ZUR ANISOTROPIE UND RELAXATION DES PLASMAS AM ISAR I MEGAJOULETHETAPINCH]
C. Andelfinger, E. Fuenfer, G. Lehner, H. Paretzke, F. Pohl et al Aug. 1967 56 p refs In GERMAN; ENGLISH summary
(IPP-1/67)

Theoretical considerations based on the Fokker–Planck equation taking into account both ion–ion and ion–electron collisions and their influence on the relaxation of the ion anisotropy are presented. Theory shows that for an anisotropic plasma the neutron flux and energy spectrum from D–D reactions is anisotropic, too. These predictions are compared with recent measurements on the Isar I megajoule theta pinch. The measurements concern the anisotropy and axial distribution of the neutrons. Particle densities and end losses were studied by interferometric means. These measurements yield the perpendicular and parallel temperatures and the particle densities as functions of time. The maximum perpendicular ion temperatures are about 5 keV. The parallel ion temperatures taken from the rate of end losses are small in the beginning and increase quite fast after about a quartercycle. Detailed computations on the relaxation using the above-mentioned theoretical results are in very good agreement with the observations. Author

N67-40394 Institut für Plasmaphysik G.m.b.H., Garching (West Germany).
CYCLOTRON WAVES IN A HOT, CYLINDRICAL PLASMA WITH AN INHOMOGENEOUS MAGNETIC FIELD [ZYKLOTRONWELLEN IM HEISSEN, ZYLINDRISCHEN PLASMA MIT INHOMOGENEM MAGNETFELD]
H. Grawe Jul. 1967 84 p refs In GERMAN; ENGLISH summary
(IPP-6/60)

A method of calculating the propagation of rotational symmetric waves in a hot, circularly cylindrical plasma with a weakly inhomogeneous magnetic field is described. Cyclotron waves, in particular, are taken into account as well. From a model for cyclotron damping it is shown that in a weakly inhomogeneous magnetic field the cyclotron damping is independent of the strength of the inhomogeneity. It is therefore possible to replace the weakly inhomogeneous magnetic field in the usual way with a partially homogeneous field. The Vlasov equation is taken as a basis to calculate the dielectric tensor and the pressure tensor for rotational symmetric waves in a homogeneous plasma with a homogeneous magnetic field. The dispersion relation thus obtained is the condition for the vanishing of a 5×5 determinant. In general it can only be solved numerically. Restrictions on the frequency are subsequently introduced in order to reproduce known results. Author

N67-40395 Institut für Plasmaphysik G.m.b.H., Garching (West Germany).
AN ELECTROSTATIC ANALYZER FOR MEASURING THE ENERGY OF IONS AND ELECTRONS FROM HOT PLASMAS [EIN ELEKTROSTATISCHER ANALYSATOR ZUR MESSUNG DER ENERGIE VON IONEN UND ELEKTRONEN AUS HEISSEN PLASMEN]
Helmuth Niedermeyer Jun. 1967 68 p refs In GERMAN; ENGLISH summary
(IPP-1/66)

An electrostatic energy analyzer for recording the energy spectrum of plasma particles (electrons and positive ions) in the range of 10 eV to a few 10 keV is described. The resolution of the cylindrical capacitor used as an energy filter can be set between 1% and 3%. The transmitted particle current is measured with a scintillation detector sensitive to ions or electrons depending on the applied electrode voltages. For a time resolution of 5 ns a particle current of 10^{-7} A is measured with a statistic error of 2%. The sensitivity of the detector was calibrated absolutely with an electron and ion beam respectively. Plasma particles are admitted to the analyzer through a highly evacuated, magnetically shielded tube system that can be placed to within a few centimeters of a high temperature plasma. Author

N67-40490*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DEBYE SHIELDING IN STARK BROADENING OF ISOLATED HELIUM I LINES
G. K. Oertel [1966] 6 p refs Presented at the 8th Intern. Conf. on Phenomena in Ionized Gases, Vienna, 27 Aug.–2 Sep. 1967
(NASA-TM-X-60563) CFSTI: HC $3.00/MF $0.65 CSCL 20I

In order to treat Debye shielding effects systematically for each perturbing level and for each perturber velocity, the cutoff in the impact parameter integration was introduced prior to the

summation over perturbing levels and prior to the velocity integration. This is deemed essential because different states are shielded at different electron densities depending upon their angular frequency separation from the upper or lower level, and because complete Debye shielding occurs at relatively low electron densities for the smaller velocities. In comparison to the generalized impact theory, more interacting levels were considered for upper and lower levels of transitions; quadrupole contributions to widths and shifts were included explicity; and back reaction of the atom on the perturbers was included approximately. The numerical results, obtained on a digital computer, are tabulated. Besides multiplet number and wavelength, the table lists half halfwidths and shift to width (half halfwidth) ratios as functions of temperature and electron density. M.G.J.

N67-40534 Institut für Plasmaphysik G.m.b.H., Garching (West Germany).
INVESTIGATION ON A THETATRON PLASMA NEAR THE PLASMA FREQUENCY [UNTERSUCHUNG AN EINEM THETA-PINCH PLASMA IM BEREICH DER PLASMAFREQUENZ]
D. Gross Jun. 1967 56 p refs In GERMAN; ENGLISH summary
(IPP-1/65)

This investigation discusses to what extent the theory of radiation emission near the plasma frequency agrees with time- and space-resolved infrared emission intensities of a thetatron plasma. A new type of infrared optical system allowing radial resolution of the plasma radiation was designed for this purpose. A frequency band around 2.5 THz was filtered out and recorded with a helium-cooled, impurity-activated photo-detector with a time resolution of 80 nsec. The radiation intensities of a dense thetatron plasma were recorded and compared with the results of a computer program. The results of both calculations are in quantitative agreement with the infrared measurements except for a short radiation peak during the shock wave phase of the discharge. This peak can be interpreted, however, by means of a semi-quantitative evaluation as a microinstability-induced radiation burst originating from the outside surface of the compression shock wave. Author

N67-40555*# Columbia Univ., New York. Electronics Research Labs.
THE FLUID TRANSPIRATION ARC AS A RADIATION SOURCE FOR SOLAR SIMULATION Semiannual Progress Report, 1 Jan.–30 Jun. 1967
C. Sheer and S. Korman 30 Jun. 1967 37 p refs
(NASA Order R-47-017-001; Contract AF 49(638)-1395)
(NASA-CR-89738; P-3/312; AFOSR-67-2363) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The project to develop a fluid transpiration arc radiation source for solar simulation was initiated. The background of the fluid transpiration arc, including a discussion of both the cylindrical offset and conical coaxial geometries, is presented. A description of certain features that offer possibilities of improved source performance is also included. In particular, the high ionization of the FTA anode column plus the effectiveness of high velocity cathode injection to enhance brightness and inhibit cathode ablation has led to a new concept for a plasma source. This involves a colinear opposing flow geometry to generate a large stagnant zone in the arc region of maximum excitation. A preliminary successful experiment on this configuration at 1 atm. pressure is described. The design and procurement of the first source of this type designed to operate at high pressures, including pressure vessel and recirculation system, as well as a complete system for radiometric measurements are also discussed. Author

26 PHYSICS, SOLID-STATE

Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

N67-39401# Colorado Univ., Boulder. Dept. of Physics and Astrophysics.
MAGNETORESISTANCE AND HALL EFFECT IN p-TYPE GERMANIUM
William F. Love and Jean W. Gallagher Aug. 1967 34 p refs
(Contract Nonr-1147(12))
(TR-4; AD-657851)

The transverse magnetoresistance and Hall effect between 16 and 70 K were measured in p-type germanium in fields up to 165 kgauss. The zero-field resistance at 77 K was approximately 2.4 ohm-cm. Samples oriented with H in the (111) direction, I random; H in the (001) direction, I in the (110) direction; H in the (110) direction, I in the (001) direction; and H in the (110) direction, and I in the (110) direction were investigated. The magnetoresistance was found to be approximately linear in H with little dependence on orientation. The Hall coefficient was independent of H above 30 K but increased with H at lower temperatures due to magnetic freeze-out of carriers. Author (TAB)

N67-39406# Lincoln Lab., Mass. Inst. of Tech., Lexington.
HALL COEFFICIENT AND TRANSVERSE MAGNETORESISTANCE IN HgTe AT 4.2°K AND 77°K
Theodore C. Harman, Jurgen M. Honig, and Philip H. Trent 25 Aug. 1967 30 p refs
(Contract AF 19(628)-5167)
(ESD-TR-67-484; TN-1967-43; AD-658089)

A band structure model is proposed which is consistent with magneto-Hall and magneto-resistance data obtained for various samples of HgTe at 4.2K. Using an optimization routine it was ascertained that the data could be fitted on the basis of a three-carrier model involving two sets of electrons and one set of holes. Under special crystal growth conditions the electron Hall mobility at 4.2K of HgTe exceeded 640,000 sq cm/v-sec. Author (TAB)

N67-39425# Johns Hopkins Univ., Baltimore, Md. Dept. of Physics.
LASER RAMAN SCATTERING STUDIES OF CRYSTALS Semiannual Progress Report, 16 Dec. 1966–16 Jun. 1967
Herman Z. Cummins 1 Aug. 1967 16 p refs
(Contract Nonr-4010(06); ARPA Order 306-63; Proj. Defender)
(AD-658342)

Temperature dependent Raman spectroscopy of quartz has revealed the existence of a new optical lattice vibration mode which appears to play a fundamental role in the alpha-beta phase transition. Continued temperature dependent Raman measurements of Strontium Titanate have also disclosed a new moving component in the spectrum. Additional measurements have also shown that the three sharp Raman lines which are present at all temperatures below the 110 degrees K cubic to tetragonal transition probably arise from local breaking of the translational symmetry by inhomogeneous strain within the domain walls. Intensity vs. temperature measurements of the strong component at 78 reciprocal cm (room temperature value) have failed to confirm our earlier conclusion that part of the room temperature Raman spectrum of Strontium Titanate is of first order. Preliminary Raman measurements have been performed on KDP, and have failed to produce conclusive evidence for an anticipated soft mode which was predicted by Cochran. TAB

N67-39429 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
NEUTRON-DIFFRACTION STUDY OF ANTIFERROMAGNETISM IN USb_2 AND UBi_2 [NEUTRONOGRAFICZNE BADANIE STRUKTURY ANTYFERROMAGNETYCZNEJ W USb_2 I UBi_2]
J. Leciejewicz, R. Troc, A. Murasik, and A. Zygmunt 1967 19 p refs Transl. into ENGLISH from Polish
(INR-P-796/II/PS) Available from Nucl. Energy Inform. Center, Warsaw

Magnetic ordering in polycrystalline USb_2 and UBi_2 has been determined by neutron diffraction. The magnetic unit cell in USb_2 is twice the chemical one along the c-axis. Ferromagnetic layers are stacked along the c-axis with the sequence +—+. In UBi_2 the magnetic and chemical unit cells coincide. The ferromagnetic layers are also stacked in the direction of the c-axis with a sequence +—+—. In both substances the magnetic moments of U are parallel to the fourfold axis. Their magnitudes are: 0.94 ± 0.03 BM in USb_2 and 2.1 ± 0.1 BM in UBi_2. Author

N67-39503# National Cash Register Co., Dayton, Ohio. Research Div.
RESEARCH AND DEVELOPMENT OF CATHODOLUMINESCENT PHOSPHOR WITH HIGH-INTENSITY ULTRAVIOLET EMISSION Final Report, 1 Aug. 1964–31 Jan. 1966
J. W. Gilliland and F. G. Ullman Jun. 1967 143 p refs
(Contract DA-28-043-AMC-00304(E))
(ECOM-00304-F; AD-657589)

The objective of the program was to synthesize a cathodoluminescent phosphor with greatly increased ultraviolet emission efficiency in the spectral region between 350 and 400 nanometers for the purpose of writing on photochromic or Kalvar media. Twenty-nine phosphor compositions were studied in at least a preliminary manner and several of these more extensively. Relative to P-16 powder, sprayed films of calcium magnesium silicate: cerium showed an average writing efficiency on Kalvar nearly ten times greater in a demountable system. Another sprayed film phosphor, $BaZn1.9Mg0.1Si2O7$:Pb with spectral peak at about 300 nm was shown to be about ten times more efficient than P-16 powder in writing on a spiropyran photochromic film in a demountable system. Demonstration cathode ray tubes were fabricated with the sprayed phosphor films, $BaSi2O5$:Pb, calcium magnesium silicate: cerium, and $Zn2SiO4$:Ti, and settled powder P-16 screens incorporated. Phosphors in cathode ray tubes generally were no better than presently available P-16 except for solution sprayed barium silicate: lead activated. This phosphor exhibited a relative writing efficiency four times greater than P-16 phosphor on photochromic film. TAB

N67-39513# Israel Inst. of Tech., Haifa. Technion Research and Development Foundation, Ltd., Haifa (Israel).
SUPERPARAMAGNETIC BEHAVIOR OF SOLIDS AT LIQUID HELIUM TEMPERATURES Final Scientific Report, 1 Jan. 1963–31 Dec. 1966
Aaron A. Hirsch 28 Feb. 1967 78 p refs Prepared jointly with Technion Res. and Develop. Found., Ltd.
(Grant AF-EOAR-63-071)
(AFOSR-67-2002; AD-657804)

It is shown in this work that the individual particles of fine powders of ferromagnetic materials represent aggregates of subdomain volumes which are magnetically coupled by means of magnetostatic, magnetoelastic and exchange forces. These forces are responsible for the establishment of an inhomogeneous magnetization within these particles. The magnetization process within the subdomains is assumed to be caused by growth of magnetic nuclei and by thermal fluctuations which are characteristic of the superparamagnetic state. The mechanism of this process is responsible for the slow magnetization relaxation phenomena observed in fine powders. As found these phenomena become very pronounced at liquid helium temperatures. The magnetization process in granular multilayer films behaves in a way which is similar to that of fine powders when the thicknesses of the individual layers are very small so that superparamagnetic properties can be exhibited. Cold rolled ferromagnetic metal with large roll reduction in thickness show a similar magnetic behavior because of their laminated structure. The inhomogeneous magnetization within the different laminations of the multiple films can be investigated using the magnetoresistance effect as an experimental tool.
Author (TAB)

N67-39558# Lincoln Lab., Mass. Inst. of Tech., Lexington.
TETRAHEDRAL-SITE COPPER IN CHALCOGENIDE SPINELS
John B. Goodenough 23 Aug. 1967 10 p refs
(Contract AF 19(628)-5167)
(ESD-TR-67-481; TN-1967-42; AD-658027)

The ferromagnetism and metallic conductivity of the compounds Cu(Cr2)X4, where X = S, Se, or Te, have been interpreted in terms of collective d electrons of t2g symmetry from Cu(2+) ions and localized d electrons of t2g symmetry at Cr(3+) ions. Lotgering and van Stapele have studied the compounds CuCrRhSe4, CuCrTiS4, and M1-xCu(Cr2)Se4, where M = Zn, Cd, or Hg. They have asserted that their results disprove this hypothesis and strongly support the existence of Cr(4+) ions in the presence of Cu(+) ions. It is shown that these assertions are incorrect.
Author (TAB)

N67-39579*# Field Emission Corp., McMinnville, Oreg.
INVESTIGATIONS OF ELECTRON EMISSION CHARACTERISTICS OF LOW WORK FUNCTION SURFACES Quarterly Report, 28 Sep.–27 Dec. 1966
L. W. Swanson, A. E. Bell, L. C. Crouser, and B. E. Evans Feb. 1967 29 p refs
(Contract NASw-1516)
(NASA-CR-89661; Rept.-1; QR-1) CFSTI: HC $3.00/MF $0.65 CSCL 20L

A field emission study of cesium and fluorine coadsorbed on tungsten is reported. Work function minima as low as 1.0 eV are reported along with the effect of coadsorbed fluorine on the migration and desorption rates of cesium. Although cesium can be thermally desorbed throughout most of the coverage range from a fluorinated tungsten surface without disturbing the underlying fluorine layer, there is evidence that at low cesium coverages thermal desorption of cesium enhances the removal of the otherwise stable fluorine layer. Also reported is a study of the mechanisms leading to decay of field emission current from a low work function zirconium/oxygen coated tungsten emitter. The results obtained thus far indicate electron induced desorption of neutral and ionic particles from anode surfaces, which impinge on the emitter surface, as the main cause of the time decay of field emission current.
Author

N67-39581# Sheffield Univ. (England). Dept. of Physics.
PARAMAGNETIC RESONANCE IN RARE EARTH METALS Final Scientific Report, 1 Jun. 1966–31 May 1967
R. S. Tebble, A. M. Harris, Brian Johnson, and D. W. Temple 31 May 1967 19 p refs
(Grant AF-EOAR-65-60)
(AFOSR-67-1961; AD-657790)

Apparatus for the observation of spin wave resonance (SWR) in rare earth metal films in magnetic fields of 27 Koe and at liquid nitrogen temperatures was developed. Although SWR was observed in evaporated iron and nickel films none has been observed

in gadolinium. This may be due to oxidations during preparation, magnetostrictive strains in the crystal dispersion in the magnetization, or a combination of these. The problems involved in the preparation of these films were defined and a programme of producing thin gadolinium films and examining them by transmission electron microscopy was commenced. The use of Lorentz electron microscope techniques allow of the simultaneous examination of magnetic and crystallographic structure. Author (TAB)

N67-39594* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ENERGY LEVELS AND TRANSITION PROBABILITIES OF Mn^{4+}:TiO_2 AND Cr^{3+}:$ZnWO_4$

H. A. Sabbagh (Rose Polytech. Inst.), B. E. Raff (Ross Polytech. Inst.), and R. E. Stuffle (Rose Polytech. Inst.) Sep. 1967 84 p refs

(Grant NGR-15-008-004)

(NASA-TM-X-55972; X-523-67-488) CSCL 20L

Data on the energy levels and transition probabilities for Mn^{4+}:TiO_2 and Cr^{3+}:$ZnWO_4$ are presented. The important parameters are the magnitude and orientation of the external d.c. magnetic field. In addition, the orientation of a linearly polarized r.f. magnetic field which results in a maximum transition probability is tabulated. Author

N67-39596# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

GROWTH OF EPITAXIAL GERMANIUM FILMS FROM SUPERCOOLED DROPS

N. N. Shefmal', Ye. I. Givargizov, B. V. Spitsyn, and A. M. Kevorkov 28 Feb. 1967 14 p refs Transl. into ENGLISH from Akad. Nauk SSSR, Inst. Kryst. (Moscow), no. 4, 1964 p 15–21

(FTD-HT-66-435; AD-658650)

Crystallization of Ge from the gaseous phase formed by the reduction of GeCl4 with H, at (GeCl4):(H2) = 0.0013-0.004, was studied in the high-temp. region, >740C, on single-crystal plates of Ge oriented with (111), (110), and (100) faces. As the gas mixt. approached the plate, it attained a temp. sufficient to form a complex of several atoms. The complex grew rapidly by virtue of the autocatalytic effect of the Ge plate. This was supported by the fact that increasing the temp. of the plate from 740 to 790C increased the amt. of Ge deposited by plus or minus 10%. Reducing the rate of flow of the gas through the tube from 0.9 to 0.3 cm/sec., increased the size of the drop, i.e. the drop grew while still in the gaseous medium and not after it settled on the plate. The deposited film was shown to be a single-cryst. film. Author (TAB)

N67-39603# Johns Hopkins Univ., Baltimore, Md. Dept. of Physics.

BRILLOUIN SCATTERING EXPERIMENTS IN THE FERROELECTRIC CRYSTAL TRIGLYCINE SULFATE

Robert W. Gammon and Herman Z. Cummins [1966] 185 p refs

(Contract DA-31-124-ARO(D)-400; ARPA Order 675; Proj. Defender)

(TR-2; AD-658167)

Brillouin scattering measurements were made on triglycine sulfate near its Curie temperature (TC). Temperature and field dependent single relaxation time acoustic velocity dispersion was found in confirmation of the predictions of a simple free energy expansion theory of the dynamics of the strain and polarization fluctuations near TC. Additional experimental results obtained for triglycine sulfate include measurement of the acoustic mode velocities for all three modes for various directions in the (010) plane, measurement of the longitudinal velocity along the ferroelectric axis, a measurement of a reference absolute cross section for Brillouin scattering in triglycine sulfate, and determination of some of the Pockels coefficients from the Brillouin component intensity in various directions. Author (TAB)

N67-39623# Oak Ridge National Lab., Tenn. Isotopes Development Center.

A STUDY OF RADIATION DAMAGE AND SUBSTITUTIONAL CHEMICAL IMPURITY EFFECTS IN SINGLE-CRYSTAL GERMANIUM SUBJECTED TO 40-KeV. B^+, P^+, Al^+, As^+, AND Sb^+ IONIC BOMBARDMENT

G. D. Alton (M.S. Thesis—Tenn. Univ., Knoxville) Aug. 1967 100 p refs

(Contract W-7405-ENG-26)

(ORNL-4142) CFSTI: HC$3.00/MF$0.65

The time-temperature annealing of damage centers produced in germanium by substitutional impurity ions and the properties of p-n junctions after damage annealing were investigated. Physical effects occurring during energetic bombardment of surfaces, some properties of semiconductors, and radiation damage in semiconducting materials are discussed. Thermoelectric probe measurements on n-type Ge prior to annealing supported the findings of others that regardless of the chemical identity of the energetic ion, acceptor states result. Subsequent annealing suggested that the damage centers begin to anneal away at about 200°C and that annealing is complete at about 550°C. The density of damage centers produced as a result of bombardment increased with ion mass and/or size. Resistivity changes as a result of bombardment up to 2×10^{15} ions/cm^2 were insignificant regardless of the mass and size of the particle. Data seemed to indicate that the resistivity changes observed are due to chemical impurities moving into substitutional positions rather than defect annealing. NSA

N67-39626# Stanford Univ., Calif. High Energy Physics Lab.

THE MICROWAVE SURFACE RESISTANCE OF SUPERCONDUCTING LEAD, TRAPPED MAGNETIC FLUX, AND A NEW MAGNETOMETER USING SUPERCONDUCTIVITY

John Morley Pierce Jun. 1967 84 p refs

(Contract Nonr-225(67))

(HEPL-514; AD-657931)

An investigation has been made into the causes of the residual surface resistance which is always observed in superconductors at microwave frequencies. A new and extremely sensitive magnetometer has been developed which uses unique properties of superconductivity. Calculations and measurements indicate that this magnetometer can detect a field change of 3 x 10 to the minus 10th power gauss in a loop with 1 cm radius. The magnetometer uses a superconducting loop in which a field change is translated into a persistent current. Linking the loop is a cylinder of superconductor which can be switched alternately between the normal and superconducting states at a frequency of 150 KHz. Since the magnetic flux linking a superconducting cylinder is quantized, inductive impulses are given to the loop, and a large oscillation is built up which is proportional to the persistent current. The result is an output power equivalent to spinning the sensing loop at a frequency approximately 1,000,000 Hz. This accounts for the great sensitivity. Author (TAB)

N67-39709# Ohio State Univ. Research Foundation, Columbus.

LOW TEMPERATURE THERMAL EXPANSION OF WURTZITE-PHASES OF IIB-VIB COMPOUNDS. PART I: THERMAL EXPANSION OF ZnS, WURTZITE FROM 2°K TO 317°K Final Report, 5 Jan. 1966–31 Jul. 1966

R. R. Reeber and G. W. Powell Wright-Patterson AFB, Ohio. ARL. Jun. 1967 21 p refs
(Contract AF 33(615)-2270)
(ARL-67-0123, Pt. I; AD-658026)

Thermal expansion measurements of the wurtzite phase of CdS(5) and the zincblende phase of ZnS(6) have indicated that negative values of molar volume coefficients of expansion are to be expected from open structures, especially those like ZnS which have low shear moduli. In this experiment the thermal expansion of the wurtzite phase of ZnS was measured using a back reflection Debye-Scherrer X-ray camera. The minimum value of the molar volume was found to occur at 60 degrees plus or minus 5K. Experimental results indicate that retrograde behavior is found both parallel and perpendicular to the c-axis in ZnS. The total decrease in molar volume from 300K to the minimum volume obtained was approximately 0.3%. Author (TAB)

N67-39712*# Field Emission Corp., McMinnville, Oreg.
INVESTIGATIONS OF ELECTRON EMISSION CHARACTERISTICS OF LOW WORK FUNCTION SURFACES Quarterly Report, 28 Dec.–27 Mar. 1967
L. W. Swanson, A. E. Bell, L. C. Crouser, and B. E. Evans Apr. 1967 20 p refs
(Contract NASw-1516)
(NASA-CR-89663; Rept.-2; QR-2) CFSTI: HC $3.00 CSCL 20L

This report describes thermal and field desorption of Cs from a fluorinated tungsten surface. The binding of Cs to a W substrate is increased by the presence of coadsorbed F. The field desorption of Cs from a FW surface occurs at low temperatures without disturbing the underlying FW layer. The time stability of the field emission current from a clean or Zr/O coated tungsten surface is greatly enhanced if positive ions formed at the electron collector surface are not allowed to return to the emitter cathode. Author

N67-39717# Lincoln Lab., Mass. Inst. of Tech., Lexington.
THE GaAs-InSb GRADED GAP HETEROJUNCTION
Everett D. Hinkley and Robert H. Rediker 15 Aug. 1967 54 p refs
(Contract AF 19(628)-5167)
(ESD-TR-67-468; TN-1967-40; AD-657777)

The interface-alloy technique has been used to produce heterojunctions between GaAs and InSb. X-ray and Kossel line patterns show that, despite the relatively large 14% lattice mismatch between the semiconductors, these heterojunctions are single-crystal. Photocurrent and current-voltage measurements are explained by a model for the heterojunction band structure in which the salient feature is a region of the order of 60 A long which has a linearly-graded energy gap joining the GaAs to the InSb. The photocurrent occurs via hot carriers generated in the graded-gap region which traverse this region (with a mean free path of approximately 20 A) to the heterojunction barrier maximum. The results of the capacitance-voltage measurements are consistent with the current-voltage and photocurrent measurements evaluated in terms of the graded-gap heterojunction model. TAB

N67-39731# Colorado Univ., Boulder.
EXPLORATORY RESEARCH OF MAGNETIC MATERIALS BY ULTRASONIC TECHNIQUES Final Progress Report
A. W. Bevan, Jr., A. C. Daniel, and R. J. Mahler (National Bureau of Standards) Jul. 1967 22 p refs
(Contract DA-ARO-D-31-124-G860)
(Rept.-6998.2-RT; AD-658467)

The ultrasonic attenuation in a single crystal of MnF2 was investigated; and the temperature dependence of nuclear spin-lattice relaxation times in NaBrO3 and in the antiferromagnetic crystals CoF2, CoCl2.2H2O, and FeCl2.2H2O were determined. Author (TAB)

N67-39732# Illinois Univ., Urbana. Dept. of Mining, Metallurgy and Petroleum Engineering.
DYNAMICAL BAHAVIOR OF DISLOCATIONS
John J. Gilman Sep. 1967 39 p refs
(Contract Nonr-3985(06))
(AD-658874)

Direct and indirect measurements of dislocation mobilities are reviewed. It is pointed out that no single functional relation between dislocation velocity and stress exists. Four limiting cases are classified schematically: (a) pure metals and salts (b) covalent crystals and impure others; each at low and high stress levels. For cases (a) and (b) at low stress levels linear viscosity is observed. It is pointed out that a previous treatment of the viscous drag by Mason neglects the dominant role of glide plane sliding and a new treatment is presented. For case (b) at high stress levels (low temperatures) flow is stress-activated and a model based on quantum-tunneling is presented and shown to compare favorably with experiments. The behavior of heterogeneous crystals is discussed. A model proposed by Copley and Kear that predicts dynamic anisotropy is reviewed. Author (TAB)

N67-39861* Case Inst. of Tech., Cleveland, Ohio.
SiO_2/Si INTERFACE STATES AT 77°K
A. B. Kuper, H. P. Caban-Zeda, and E. Greenstein [1967] 11 p refs
(Grant NGR-36-003-067)
(NASA-CR-89741) CSCL 20L

Interface states in conventional SiO_2/Si have been studied by MOS C(V) at 1 mc. at 77°K. In addition to the flat-band voltage shift in dry oxides, two other effects are found at 77°K. In addition to the flat-band voltage in dry oxides, two other effects are found at 77°K: (1) a plateau region in the depletion portion of the C(V) characteristic and (2) large hysteresis in the depletion portion in the dark, of opposite sense for n- and p-type. Large hysteresis is due to transient depletion and to locked-in charge in interface states which appear to be distributed with some symmetry in the energy gap. States are discharged by minority carriers produced by light or by breakdown in the Si depletion region at high reverse bias. Author

N67-39908# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
THE ABSORPTION SPECTRA OF THORIUM DIOXIDE
J. Lambert Bates Jul. 1967 16 p refs
(Contract AT(45-1)-1830)
(BNWL-457) CFSTI: HC $3.00/MF $0.65

The absorption spectra of single crystal and polycrystalline ThO_2 were determined for the spectral range 0.247 to 13 μ. Complex changes in the ultraviolet and visible spectra occurred when the oxide was heated in hydrogen or air. Absorption bands at 0.71 μ and 0.403 μ were observed when ThO_2 was annealed in hydrogen at 1700°C. Annealing ThO_2 in air at 1000°C removed these bands and produced an intense band at 0.306 μ. The absorption in the infrared range was the same for both single crystal and polycrystalline ThO_2, and was independent of the annealing conditions. The characteristic absorption edge is 5.02 eV. Author (NSA)

N67-39912 Polish Academy of Sciences, Cracow. Inst. of Nuclear Physics.
APPLICATION OF NUCLEAR MAGNETIC RESONANCE TO POLYMER CRYSTALLINITY MEASUREMENTS [ZASTOSOWANIE MAGNETYZCNEGO REZONANSU JADROWEGO DO POMIARU STOPNIA KRYSTALICZNOSCI POLIMEROW]

Z. Florkowski, J. W. Hennel, I. M. Pollak-Stachurowa 1967 21 p refs In POLISH
(INP-551/PL) Available from Nucl. Inform. Center, Warsaw

The degree of crystallinity was measured in two polyamides from 20°C to 50°C using a broad line magnetic resonance spectrometer. Good sensitivity of the method was found. Author

N67-39946# Union Carbide Corp., Indianapolis, Ind. Speedway Labs.
SINGLE CRYSTAL PEROVSKITES AS ELECTROOPTICALLY ACTIVE MATERIALS Quarterly Progress Report, 1 Jan.–1 Apr. 1967
H. Fay 1 Apr. 1967 42 p ref
(Contract AF 33(615)-5410)
(SRCR-67-12; QPR-3; AD-658461)

The Czochralski growth of KTN was continued in order to determine reproducibility. In addition, a new growth technique was tested. Thirteen perovskite compounds were selected from the computer output data for melt studies on the strip heater. Twelve of the best KTN crystals were fabricated, etched, and tested for electrooptic properties; one crystal was operated as a switch for a Nd:YAG laser. Author (TAB)

N67-39981* Scientific Translation Service, La Canada, Calif.
ELECTRONIC AND OPTICAL PHENOMENA AND THE ADSORPTION OF GASES. ELECTRICAL PROPERTIES OF MONOMOLECULAR FILMS. PART II [II. ELEKTRONNYYE I OPTICHESKIYE YAVLENIYA I ADSORBTSIYA GAZOV. ELEKTRICHESKIYE SVOYSTVA MONOMOLEKULYARNYKH PLENOK]
A. I. Ansel'm Jul. 1967 11 p refs Transl. into ENGLISH from Uch. Zap. Leningr. Gos. Univ., Ser. Fiz. Nauk (Leningrad), v. 38, no. 5, 1939 p 16–25
(Contract NASw-1496)
(NASA-TT-F-11153) CSCL 20L

The Langmuir–Saha formula is derived in a simple way. The photoconductivity processes in active metal films are studied based on simplifying assumptions. Author

N67-40076 Joint Publications Research Service, Washington, D. C.
CHANGES IN THE MECHANICAL CHARACTERISTICS OF SOME SOLIDS FROM THE ACTION OF GAMMA-RAYS
S. V. Starodubtsev, S. A. Azizov, I. A. Domoryad, Ye. V. Peshikov, and L. P. Khiznichenko *In its* Properties of Some Ceram. and Insulating Mater. 18 Sep. 1967 p 30–42 refs Transl. into ENGLISH from the book "Deystviye Yadernogo Izlucheniye na Materialy" USSR, Acad. of Sci. USSR, 1962 p 347–354 (See N67-40072 24-18)

Experiments were conducted to determine the effect of gamma radiation on the mechanical and dielectric properties of samples of fused quartz in the form of fibers, crystals of Seignette salt of various sections, and ceramic barium titanate. Irradiation was carried out in a Co^{60} gamma apparatus with an energy of 1.25 MeV and a dose rate of 10^6 roentgens/hour. Also discussed are the methods of recording the radiation changes for each sample, which were developed to meet the criteria for high sensitivity and accuracy. The findings indicate: (1) Due to the action of the gamma rays, the shear modulus of fused quartz increases with increasing irradiation dose, and changes occur in the linear dimensions. (2) The effects of intensive gamma irradiation observed on the linear dimensions and melting point of Siegnette salt are apparently related to the destruction of the sample. (3) A noticeable effect on the dielectric and elastic properties of titanium–barium ceramics was discovered. (4) The radiation changes observed are qualitatively similar to the aging process and are either identical to them or related to an analogous mechanism. M.G.J.

N67-40089*# Stanford Research Inst., Menlo Park, Calif.
EFFECT OF ENVIRONMENT ON THERMAL CONTROL COATINGS Interim Report
S. R. Morrison and T. Freund 1 Sep. 1967 25 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951522; SRI Proj. Pad-6146)
(NASA-CR-89555; IR-1) CFSTI: HC $3.00/MF $0.65 CSCL 20M

The use of additives to provide surface recombination centers on thermal control coatings, and thus to stop optical degradation, has been explored. Various chemical surface additives have been examined to test their electron and hole capture efficiency. Out of the group examined, iron was selected as the most promising. Preliminary tests of ZnO with this additive indicated no detectable damage when the ZnO was exposed to ultraviolet radiation under vacuum; permanent changes in resistance were used as the measure of damage. The required research to determine and test an optimized additive is discussed. Measurements to determine the degradation mechanism on additive-free ZnO are discussed and a theoretical model of degradation from ultraviolet radiation under vacuum is presented. Author

N67-40110# Parke Mathematical Labs., Inc., Carlisle, Mass.
THEORETICAL ANALYSIS OF A SECONDARY EMISSION EXPERIMENT ON INSULATORS Scientific Report
Charles H. Sherman and Nan E. Gordon Jul. 1967 46 p refs
(Contract AF 19(628)-2419)
(AFCRL-67-0459; SR-7; AD-658831)

A mathematical model is developed of a simple experimental situation involving secondary electron emission and radiation induced conductivity in insulating materials. The observable current is related to other variables and to various material properties, and a practical numerical method of computation is given. Typical numerical results obtained with the help of a Fortran program for the IBM 1130 computer are presented and discussed. The model is expected to be useful in planning experiments and in interpreting experimental data. TAB

N67-40160* Farnham (Frank C.) Co., Philadelphia, Pa.
ON THE THEORY OF FIELD EMISSION IN SUPERCONDUCTORS [K TEORII AVTOELEKTRONNOY EMISSII V SVERKHPROVODNIKAKH]
G. A. Gogadze and I. O. Kulik Washington, NASA, Oct. 1967 13 p refs Transl. into ENGLISH from Fiz. Metal. i Metalloved. (USSR), v. 23, no. 4, 1967 p 606–615
(Contract NASw-1497)
(NASA-TT-F-11281) CSCL 20L

The distribution of electrons emitted from a superconductor with respect to total energy and its normal component was determined. Both distribution functions revealed a strong difference from the corresponding functions for a normal metal in a narrow range of energies near the Fermi level. The total change of the field current upon transition of the metal from a normal state to a superconducting state was very small. Computations were based on use of the Cohen–Falicov–Phillips tunnel Hamiltonian method. Author

N67-40175# Boeing Scientific Research Labs., Seattle, Wash. Solid State Physics Lab.
ELECTRICAL RESISTIVITY OF BORON FIBERS
R. F. Deacon Aug. 1967 20 p refs
(D1-82-0642; AD-658896)

The d.c. overall resistivities of composite filaments composed of boron deposited on a conducting wire core, vary from 2600 micro-ohms cm for tungsten core to 8.5 ohms cm for silica/carbon core. The contact resistance, which is large, of the tungsten material is very sensitive to contact length because of the high resistance of the boron sheath, and is described to a first order by the equation derived in the paper. Doping the boron to reduce its resistance would improve this situation. TAB

N67-40177# Royal Inst. of Tech., Stockholm (Sweden). Microwave Dept.
HOT ELECTRON POLAR SCATTERING IN InSb Scientific Report
C. Hammar and P. Weissglas 13 Jul. 1967 12 p refs
(Contract AF 61(052)-895)
(SR-20; AD-658452)

The energy and momentum relaxation of conduction electrons by optical phonons in InSb is studied. The energy band structure calculated by Kane is used. For simplicity, the drifted Maxwellian approach is used and its form for an arbitrary band structure presented. No intrinsic breakdown is obtained. On the contrary, the model gives a voltage-controlled differential negative mobility for high fields. Author (TAB)

N67-40203# Naval Radiological Defense Lab., San Francisco, Calif.
RADIATION EFFECTS IN THERMOELECTRICS. 2: PERMANENT AND QUASI-PERMANENT EFFECTS OF PILE BOMBARDMENT ON SEVERAL COMPOUND SEMICONDUCTORS
John W. Winslow 18 Jul. 1967 107 p refs
(USNRDL-TR-67-83; AD-658326)

The effects of reactor bombardment on the thermoelectric properties of several compound semiconductors have been observed experimentally for exposure doses up to 2.3 x 10 to the 19th power fast (E > 1 MeV) neutrons/sq cm. Results are reported for the following materials: PbTe; Ge.95Bi.05T3; Ag2Se; n- and p-types of a Ge-Si alloy whose exact composition is classified; (GeTe)90%(AgSbTe2)10%; CoSi; n- and p-types of commercial grade Bi2Te3; and single-crystal, stoichiometric Bi2Te3. Properties measured were Seebeck coefficient, electrical resistivity, and thermal diffusivity. The effects observed ranged from an apparently simple case of change in majority charge carrier concentration due to transmutations, to rather complicated cases in which the behavior of the variables was strongly influenced, both for the better and for the worse, by post-irradiation, thermally activated processes, e.g., annealing. In some cases, no effects at all were found. Some indications that substantial improvements in the thermoelectric figure of merit for the Ge-Si alloys may be possible through appropriate sequences of irradiation and post-irradiation thermal treatment, were seen. TAB

N67-40259# Naval Air Engineering Center, Philadelphia, Pa. Aeronautical Materials Lab.
STUDY OF MAGNETORESISTANCE AND MAGNETIC SWITCHING IN FERROMAGNETIC THIN FILMS Final Report, 1 Feb.–30 Jun. 1967
Larry J. Brooks 30 Jun. 1967 42 p refs
(NAEC-AML-FR-50; AD-658497)

The study describes the fundamental behavior of a single magnetic domain under the influence of magnetic fields at small angles to the film normal. The longitudinal and transverse data are compared, and it is found, for the cases considered, that the single domain theory is valid, with the reservation that at low fields, domain formation produces an apparent attenuation of the transverse data. The apparent success of this study is compared to those by Jurretschke, and Ke and Juritsyna, is possibly due to the investigation of the governing equilibrium conditions. For each distinct field position, the solutions obtaining from these conditions are not necessarily continuous or minimum energy solutions, and care must be taken to assure that the minimum energy condition is satisfied. Author (TAB)

N67-40289# Lincoln Lab., Mass. Inst. of Tech., Lexington.
ELECTROREFLECTANCE STUDY OF INTERBAND MAGNETO-OPTICAL TRANSITIONS IN InAs AND InSb AT 1.5°K
Carl R. Pidgeon, Steven H. Groves, and Julius Feinleib 6 Sep. 1967 11 p refs
(Contract AF 19(628)-5167)
(ESD-TR-67-493; TN-1967-33; AD-658835)

The transparent electrode electroreflectance technique was used for interband magneto-optical studies of InAs and InSb at 1.5K. A report is given of the first direct experimental observation of the spin-orbit splitting, the effective mass, and the effective g-factor for the split-off band at k = 0 in InAs. TAB

N67-40309* National Aeronautics and Space Administration, Washington, D. C.
CHEMICAL SENSITIZATION OF SINGLE CRYSTAL CADMIUM SULFIDE [PRO KHIMICHNU SENSIBILIZATSIYU MONOKRISTALIV SUL'FIDU KADMIYU]
V. A. Tyagay, V. M. Bondarenko, O. V. Snitko Oct. 1967 4 p Transl. into ENGLISH from Ukr. Fiz. Zh. (Kiev), v. 12, no. 3, 1967 p 498–500
(NASA-TT-F-11308) CSCL 20L

Stimulation of the photosensitivity of CdS single crystals by chemical etching is discussed. Etching increased by a factor of 10^5 to 10^6 the photosensitivity of CdS samples with a high dark resistance. The diffusion coefficient of the sensitizing substance is given as $\approx^{-9}$ to 10^{-10} cm^2/sec. Author

N67-40312*# Stanford Univ., Calif. Solid-State Electronics Labs.
FUNDAMENTAL STUDIES OF THE METALLURGICAL, ELECTRICAL, AND OPTICAL PROPERTIES OF GALLIUM PHOSPHIDE Quarterly Progress Report, 1 Jul.–30 Sep. 1967
Gerald L. Pearson 30 Sep. 1967 20 p refs
(Grant NsG-555)
(NASA-CR-89603) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The preparation and characterization of rectifying junctions in GaP and $GaAs_xP_{1-x}$ are studied, with particular emphasis placed on the relationship of the crystal structures to the electrical properties of the junctions. Improved techniques were developed for growing GaP single crystals by either the vapor epitaxial or the liquid epitaxial methods. Also studied is zinc diffusion in GaP as a function of preannealing time. Consideration is given to the problems involved in preparing power rectifiers and solar batteries for operation at temperatures up to 500°C. To delineate the properties of gallium phosphide when doped with shallow donor impurities, experiments are being conducted in which S, Se, and Te are diffused into GaP to determine solubility and diffusion parameters. M.G.J.

N67-40340# Pittsburgh Univ., Pa.
CRYSTAL STRUCTURAL STUDIES ON SEMI-CONDUCTIVE MATERIALS Final Progress Report, 1 Jan. 1963–30 Jun. 1967

G. A. Jeffrey 14 Sep. 1967 9 p refs Sponsored in part by NSF
(Grants DA-ARO(D)-31-124-G412; DA-ARO(D)-31-124-G786)
(AROD-3975:7-P; AD-659002)

An investigation of the crystal structure of semiconducting materials is summarized. Author (TAB)

N67-40346# Naval Avionics Facility, Indianapolis, Ind.
TECHNIQUE FOR MEASURING THE HALL EFFECT IN HIGH RESISTIVITY THIN FILMS
Kashinath M. Ghanekar 21 Aug. 1967 19 p
(NAFI-TR-1086; AD-659024)

The Hall effect theory, its application and method of measurement are discussed. Techniques of measurement and attendant problems are given for the determination of resistivity, Hall coefficient and mobility in high resistivity thin films of cadmium selenide. The equipment requirements for making such measurements are listed. Author (TAB)

N67-40353*# Oak Ridge National Lab., Tenn. Thermonuclear Div.
MAGNETIC FLUX FLOW AND SUPERCONDUCTOR STABILIZATION Quarterly Report, Apr. 1–Jun. 30, 1967
W. F. Gauster, K. R. Efferson, J. B. Hendricks, D. M. Kroeger, and M. S. Lubell 9 Aug. 1967 55 p refs
(NASA Order H-29278A; Contract W-7405-ENG-26)
(NASA-CR-89971; ORNL-TM-1943) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Flux flow experiments were made with a bare strip of superconducting Nb–25% Ti. Because of low pinning forces it was possible to observe the flux flow voltage in the full range of external fields from zero to 75 kG. Near H_{c2} pronounced peak effects could be observed. It does not seem to be possible to explain the take-off points simply on the basis of the heat transfer to the helium bath. Current–voltage characteristics of a short sample of a stabilized Nb–Ti conductor were taken with currents up to 1340 Å and with external fields up to 75 kG. Also, in this case, the take-off points were not simply related to the transition from nucleate to film boiling of the surrounding liquid helium. It was possible to calculate the values of the current flowing through the superconductor at varying temperature and external fields. The temperature dependence proved to be linear. However, the field dependence measured here deviates from previous data. Some preliminary measurements of heat transfer from metal surfaces to liquid helium are discussed. Finally, a review of a previous compound conductor stability criterion is presented. Author (NSA)

N67-40404# Ohio State Univ., Columbus. Dept. of Metallurgical Engineering.
MIXED CONDUCTION IN SOLID OXIDE ELECTROLYTES
Robert A. Rapp Jun. 1967 33 p refs Presented at the Symp. on Thermodyn. of Nucl. Mater. with Emphasis on Soln. Systems, Vienna
(Contract AT(11-1)-1440; Grant NSF GP-2983)
(COO-1440-3; CONF-670915-2) CFSTI: HC $3.00/MF $0.65

At temperatures between 800° and 1100°C, electric conductivity and galvanic cell measurements involving ThO_2, Dy_2O_3, and Gd_2O_3 indicated significant ionic conductivity contributions, in addition to electronic conduction. These measurements may be rationalized either on a basis of high intrinsic ionic defect concentrations, or else ionic defects introduced by trace impurities. For ThO_2, the latter explanation seems probable. The P_{O_2}-dependence of ac conductivity measurements in ThO_2–Y_2O_3 solid solutions showed a wide P_{O_2} range of predominant ionic conductivity, with significant positive hole contributions at higher oxygen activities. The ionic conductivity contribution reaches a maximum with increasing Y_2O_3 dopant content. No significant excess electron conductivity contribution was indicated for any ThO_2–Y_2O_3 composition at oxygen activities as low as those for Cr–Cr_2O_3 equilibrium coexistence. A lower limit in P_{O_2} for predominant ionic conduction is reported for each electrolyte. Galvanic cells involving the use of the $Zr_{0.85}Ca_{0.15}O_{1.85}$ electrolyte were used to determine the solubility and diffusivity of oxygen in solid copper. Author (NSA)

N67-40435* Scientific Translation Service, La Canada, Calif.
EXPERIMENT ON THE CONSERVATION OF SUPERCONDUCTIVITY DURING ORBITAL FLIGHT [OPYT PO SOKHRANENIYU SVERKHPROVODIMOSTI V USLOVIYAKH ORBITAL'NOGO POLETA]
O. P. Anashkin, B. M. Belitskiy, V. B. Brodskiy, L. V. Kurnosova, N. N. Mikhaylov et al Washington, NASA, Sep. 1967 18 p refs Transl. into ENGLISH from the Russian
(Contract NASw-1496)
(NASA-TT-F-11248) CSCL 20L

The experimental results derived from testing the possible operation of superconductive devices on board spacecraft are discussed. Helium was employed as the coolant at a pressure of 2.4 atm (initial temperature ≈5.2°K). During the flight, the temperature was controlled at six points in the helium container, as well as the pressure in the container and the magnetic field strength in two short circuit superconducting solenoids. The measurements established the fact that this method of providing low temperatures may be successfully employed under weightlessness conditions. Author

N67-40463# United Kingdom Atomic Energy Authority, Harwell (England). Solid State Physics Div.
LONGITUDINAL OPTIC MODES IN MAGNESIUM OXIDE
R. J. Buckland and D. H. Saunderson Jun. 1967 13 p refs
(AERE-R-5467) CFSTI: HC $3.00/MF $0.65

The frequencies of longitudinal optic modes propagating along three symmetry directions in magnesium oxide have been measured on the DIDO triple-axis spectrometer. The results are compared with dispersion curves calculated by G. E. Peckham using an interionic force model fitted to neutron inelastic scattering data on lower frequency modes. Author

N67-40470# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ELECTRON PARAMAGNETIC RESONANCE OF CERTAIN COLOR CENTERS IN ALKALI–HALIDE CRYSTALS [ELEKTRONNYY PARAMAGNITNYY REZONANS NEKOTORYKH TSENTROV OKRASKI V SHCHELOGHNOGALOIDNYKH KRISTTALLAKH]
A. A. Bugay, M. A. Ruban, and A. A. Shatalov 23 Jan. 1967 13 p refs Transl. into ENGLISH from Fiz. Shcheloshnogaloidnykh Kristallov (USSR), 1962 p 432–436
(FTD-HT-66-424; TT-67-62915; AD-658649)

KCl crystals with a concentration of 5.10 to the 16th power to 2.10 to the 17 power/cu. cm. F-centers were split in halves. The EPR of the original half, used as a standard, exhibited a strong signal with a signal-noise ratio of 100. In the second half the F-centers were destroyed by optical and thermal treatment, and F2 centers formed. EPR in these specimens was absent. Hyperfine structure of EPR lines of F-centers in KCl was observed at 20.4K. The average splitting was approx. 9, which was higher than the 7.72 observed by Feber. St 77K, the hyperfine structure dissappeared. The half-width of the lines at 77 and 20.4K was 58 and 60 oe respectively. Apperently, the EPR lines did not narrow in the range 300-20.4K. Author (TAB)

N67-40511 Paris Univ., Orsay (France).
STUDY OF THE DIPOLAR IMPERFECTIONS IN LiF BY THE IONIC THERMOCURRENT METHOD [ETUDE PAR LA METHODE DES THERMOCOURANTS IONIQUES DES DEFAUTS DIPOLAIRES DANS LiF]
Carlo Laj (Ph.D. Thesis) 22 Jun. 1966 63 p refs In FRENCH

An ionic thermal current method of determining dipole impurities in lithium fluoride is described, in which the dipoles in a constant electric field are oriented at one temperature. The experimental techniques are discussed, and observations on the dipole phenomena are presented. These include the impurity concentrations, activation energy measurements, and relaxation times. Several examples are given on the application of the method. Transl. by M.G.J.

N67-40529# Laboratory for Electronics, Inc., Boston, Mass. Applied Research Dept.
RESEARCH IN FERROMAGNETICS, PART II Final Report, Apr. 1965–Mar. 1966
Robert J. Spain, Claude P. Battarel, Harvey I. Jauvtis, Michael J. Marino, and Patrick J. Peoples Sep. 1967 95 p refs Revised
(Contract AF 19(628)-4197)
(AFCRL-67-0205, Rev.; ISR-1; AD-658046)

Work has been carried out on ascertaining the feasibility of a DTPL Push Down List Memory. Investigations were made of the basic PUDL thin film shift register structure as well as the associated conductor patterns. Drive and sense electronics have been designed and breadboarded and a number of system designs have been studied and evaluated. Additional work is still required for the optimization of the thin film elements and for the completion of the feasibility model. Author (TAB)

N67-40548# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati.
POWER CONVERTERS WITH SUPERCONDUCTOR WINDINGS [TRANSFORMATORI DI POTENZA CON AVVOLGIMENTI SUPERCONDUTTORI]
F. Frazzoli and G. Sacerdoti 21 Jul. 1967 27 p refs *Its* Internal Note No. 375
(LNF-67/52) CFSTI: $3.00

Analysis of superconducting transformers indicates that they do not offer advantages in weight, volume, cost, or potential dissipation; and that they are unable to function in an alternate current regime of 10 to 20 WB/m^2. Various superconducting metals and alloy compositions are considered in terms of temperature and induction values, and attention is given to cryogenic applications of superconducting transformers. Volume and cost are plotted as a function of transformer power, and electric potential of these superconductors is reviewed. Transl. by M.W.R.

27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

N67-39482* National Bureau of Standards, Boulder, Colo. Cryogenics Div.
SLUSH HYDROGEN FLUID CHARACTERIZATION AND INSTRUMENTATION ANALYSIS Progress Report, Jan. 25–May 15, 1967
C. F. Sindt, et al 15 May 1967 27 p ref
(NASA Order H-25490A)
(NASA-CR-89658; PR-15) CSCL 21I

Emphasis during the reporting period was placed on the slush hydrogen flow system, solid hydrogen particle study, and the quality determination study. The pump and generator calibration and freeze–thaw parameters of the flow system are discussed, and the procedures for the triple-point liquid flow runs are outlined. Slush solid fraction for the flow runs was determined by the mass–energy balance method. Liquid–solid mixtures of hydrogen were stored for periods of 24, 38, 51, and 59 hours while measurements were made of the solid fraction of the settled slush and the heat leak. Among the preliminary conclusions are that solid mass fractions of at least 0.60 may be obtained with a slush age of two or more days, that aged slush immediately settles back to the percentage observed before stirring, and that there is a tendency for larger, multigrain structures to break up on aging. A graph is presented showing the densitometer output versus the density of liquid and liquid–solid mixtures of parahydrogen, and the initial results are discussed. N.E.N.

N67-39539# California Univ., Berkeley. Coll. of Engineering.
THE EFFECT OF NON-EQUILIBRIUM COMBUSTION ON PROPELLANT PERFORMANCE
Robert F. Sawyer Jul. 1967 15 p refs
(Grant AF-AFOSR-1256-67)
(TS-67-3; AFOSR 67-2004; AD-657791)

Most calculations of propellant performance, including those considering kinetic nozzle flows, are based on equilibrium composition in the combustion chamber. Departures from equilibrium combustion are cited and the effect of non-equilibrium or kinetic combustion upon propellant performance for the hydrazine/nitrogen tetroxide combination is reported. Non-equilibrium combustion may yield performance either greater than or less than equilibrium combustion. Author (TAB)

N67-39547# Stanford Research Inst., Menlo Park, Calif.
RESPONSE OF A BURNING PROPELLANT SURFACE TO EROSIVE TRANSIENTS Quarterly Report, 1 Apr.–30 Jun. 1967
G. A. Marxman, C. E. Wooldridge, and E. L. Capener 22 Aug. 1967 33 p refs
(Contract AF 49(638)-1665)
(AFOSR-67-1778; QR-6; AD-657762)

The report covers the research progress on combustion instability characteristics of solid propellants accomplished under Contract AF 49(638)-1665, during the period 1 April through 30 June 1967. During this quarter the analytical model of transient solid propellant combustion has been modified to account for a decrease in gas-phase heat release whenever there is an increase in surface-coupled heat release, and vice versa. The computer analysis has been changed to reflect this modification. Correlation of the numerically predicted behavior with the experimental results obtained previously from traveling wave studies will allow the determination of those factors that are most influential in determining the burning rate response to sudden pressure changes. Experimental studies of the detailed structure of the flame zone, using fiber optics in conjunction with high-speed photography, have shown that both ammonium perchlorate crystals and aluminum particles may ignite at or near the surface, providing further support for the concept of surface-coupled heat release. Author (TAB)

N67-39664*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
FLAME PROPAGATION INTO THE GAP OF SOLID PROPELLANT GRAIN (I)

T. Godai Redstone Arsenal, Ala., Redstone Sci. Inform. Center, 31 Jul. 1967 16 p refs Transl. into ENGLISH from the Japanese Rept.-91, 1965 p 1–12 Prepared jointly with Army Missile Command
(NASA-TM-X-60559; RSIC-693; Rept.-91) CFSTI: HC $3.00/MF $0.65 CSCL 21B

Flame propagation into a narrow gap, which is prepared perpendicular to the prime burning surface of solid propellant grain, was experimentally investigated using the test specimens of polyester–ammonium perchlorate composite propellants. Experimental results show that the flame propagates from the original burning surface into a gap when its width is larger than some critical value, and vice versa. This means that there always exists the critical value for the width of gap which is the threshold of propagation and nonpropagation of flame into it. The critical value is primarily the function of linear burning rate and the overall mechanism of flame propagation into a gap of solid propellant grain will be explained with the quenching theorem. Author

N67-39710# Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.
NON-STEADY BURNING PHENOMENA OF SOLID PROPELLANTS: THEORY AND EXPERIMENT Scientific Report, 1 Oct. 1965–30 Sep 1966
M. Summerfield, H. Krier, J. S. T'ien, and W. A. Sirignano Jul. 1967 41 p refs
(Contract AF 49(638)-1405)
(Rept.-793; AFOSR-67-1535; AD-658049)

Non-steady burning of solid propellants was investigated both theoretically and experimentally, with attention to combustion instability, transient burning during motor ignition, and extinction by depressurization. The theory is based on a one-dimensional model of the combustion zone consisting of a thin gaseous flame and a solid heat up zone. The non-steady gaseous flame behavior is deduced from experimental steady burning characteristics; the response of the solid phase is described by the time-dependent Fourier equation. Solutions were obtained for dynamic burning rate, flame temperature, and burnt gas entropy under different pressure variations; two methods were employed. First, the equations were linearized and solved by standard techniques. Then, to observe nonlinear effects, solutions were obtained by digital computer for prescribed pressure variations. One significant result is that a propellant with a large heat evolution at the surface is intrinsically unstable under dynamic conditions even though a steady-state solution exists. Another interesting result is that the gas entropy amplitude and phase depend critically on the frequency of pressure oscillation and that either near-isentropic or near-isothermal oscillations may be observable. Experiments with an oscillating combustion chamber and with a special combustor equipped for sudden pressurization tend to support the latter conclusion. Author (TAB)

N67-40145*# Union Carbide Corp., Bound Brook, N. J.
SATURATED HYDROCARBON POLYMERIC BINDER FOR ADVANCED SOLID PROPELLANT HYBRID SOLID GRAIN Quarterly Report, May 1–Jul. 31, 1967
James E. Potts, ed. 19 Aug. 1967 22 p refs
(Contract JPL-951210)
(NASA-CR-89626; QR-7) CFSTI: HC $3.00/MF $0.65 CSCL 21H

Several methods for determining the glass transition temperature of liquid prepolymers were examined in order to select a convenient method for routine examination of samples. The method of measuring the temperature at which a weighted penetrometer needle begins to sink into the glassy polymer as it is allowed to warm up through T_G was found to be fast, reliable and more suitable for screening large numbers of samples than other methods. In the molecular weight region currently of interest, the ethylene neohexene copolymers have a transition temperature near −50°C. Examples of ethylene–neohexene telomers using the halogen containing telogens are reported. Of the three methods proposed for converting terminal groups into carboxyl groups, one has yielded curable prepolymers. This method is based upon elimination of HBr from the telomer end groups, followed by oxidation of the resulting terminal double bond to give a carboxyl group. Author

N67-40166 Library of Congress, Washington, D. C. Aerospace Technology Div.
PROPELLANTS AND COMBUSTION Surveys of Foreign Scientific and Technical Literature
Serge Markov 22 Nov. 1967 46 p refs
(ATD-67-32; Rept.-3)

A 34-title bibliography is presented with analytical reviews of the selected items. Of the items, 9 pertain to fuels, 14 to oxidizers, 1 to monopropellants, 5 to high-energy propellant ingredients, 1 to metachemical propellants, 9 to additives, 12 to combustion mechanism and techniques, 1 to additive effects on combustion, and 1 to flame studies. The material is discussed in terms of subject, author and author association, and the rationale for selection of the individual items. Author and association indexes and a subject-personality-facility table are included. K.W.

28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magneto-hydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

N67-39652*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ACOUSTIC LINEAR STUDIES AT THE LEWIS RESEARCH CENTER
Bert Phillips Washington, NASA, 1967 16 p refs Presented at the 4th Combust. Conf. Sponsored by the Interagency Chem. Rocket Propulsion Group, Menlo Park, Calif., 2–13 Oct. 1967
(NASA-TM-X-52367) CFSTI: $3.00 CSCL 21H

Research on acoustic liners included the testing of arrays of isolated Helmholtz resonators in a rocket engine, and the cold flow testing of a single Helmoltz resonator. The hot testing was conducted to determine whether mean flow effects should be included in a calculation of the cavity resonant frequency and to determine the most effective axial position of an acoustic liner. The cold flow testing was conducted to determine the effects of mean flow and high wave amplitude on the resonator behavior. The results are graphically shown and discussed. R.N.A.

N67-39723*# Rocket Research Corp., Seattle, Wash.
MONOPROPELLANT HYDRAZINE THRUSTER SYSTEM Final Report, 12 Feb.–27 Nov. 1966
27 Nov. 1965 75 p
(Contract NAS5-9137)
(NASA-CR-89570; Rept.-66-R-72) CFSTI: $3.00 CSCL 21H

A program is summarized for the development and delivery of a 0.5 lbf monopropellant hydrazine thruster system intended for

use as a laboratory test model. Design and testing of a developmental hydrazine reactor are covered, along with the design, prequalification, testing, and acceptance testing of the complete hydrazine propulsion system including a propellant tank/bellows assembly, propellant valves, lines, filter, and hydrazine reactor. The hydrazine reactor utilizes Shell 405 spontaneous catalyst for the decomposition of anhydrous hydrazine. The hydrazine reactor is used with a blowdown-pressure feed system providing nominal vacuum total impulse of 350 lbf-sec. Areas of interest in the development of the hydrazine reactor were injection methods, chamber geometry, and catalyst bed packing techniques. During the program approximately 100 tests were conducted in which major effort was placed on injector optimization. Author

N67-39767* Boeing Co., Seattle, Wash. Aerospace Group.
VOYAGER SPACECRAFT SYSTEM TASK C THRUST VECTOR CONTROL STUDY Final Technical Report, Apr. 1966–Jul. 1967
Jul. 1967 171 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951111)
(NASA-CR-89734; D2-113583-1) CSCL 21H

Thrust vector control of the Voyager orbit insertion propulsion system is studied, assuming a modified Minuteman II second stage motor. Study objectives are (1) to define the necessary modifications to the existing motor's liquid injection thrust vector control (LITVC) system, and (2) to determine the physical and operating characteristics of the modified LITVC system. Four conceptually-modified alternate LITVC systems are defined and evaluated that use existing and improved hardware as well as various degrees of redundancy. The systems are analyzed as to their reliability, weight, power, tailoff control capability, control resolution, dynamic side force characteristics, and hardware status to select the preferred LITVC system from among the four alternates. Associated operational procedures for the preferred LITVC system are recommended. Author

N67-39782# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PHYSICAL PRINCIPLES OF THE WORKING PROCESS IN COMBUSTION CHAMBERS OF JET ENGINES
B. V. Raushenbakh, S. A. Belyy et al 2 May 1967 502 p refs Transl. into ENGLISH of the book "Fizicheskiye Osnovy Rabochego Protsessa v Kamerakh Sgoraniya Vozdushnoreaktivnykh Dvigateley" Moscow, Izd. Mashinostr., 1964 p 1–526
(FTD-MT-65-78; TT-67-62866; AD-658372)

The book deals with the physical principles of fuel combustion processes in air flows and methods of calculation of combustion chambers of jet engines. Consideration is given to thermodynamic and aerodynamic characteristics of combustion chambers, processes of atomization and carburetion of fuels, ignition and combustion of gas mixtures in laminar and turbulent flows, methods of flame stabilization, vibrational combustion, combustion in the wake behind a bluff body, processes of heat exchange and thermal protection of chambers. Author (TAB)

N67-39895# ARO, Inc., Arnold Air Force Station, Tenn.
EXPERIMENTAL AND ANALYTICAL STUDY OF THE H_2–AIR REACTION KINETICS USING A STANDING-WAVE NORMAL SHOCK Final Report, Sep. 1965–Jun. 1967
Roger A. Strehlow and Philip M. Rubins Arnold Eng. Develop. Center, Sep. 1967 30 p refs Presented at the AIAA 3rd Propulsion Joint Specialist Conf., Washington, D. C., 17–21 Jul. 1967
(Contract AF 40(600)-1200)
(AEDC-TR-67-177; AIAA Paper-67-479; AD-658434)

An experimental method was devised whereby the macroscopic chemical reaction history can be traced from wall pressure measurements in a high speed reacting gas in a tube. The experiments were conducted with H2 and vitiated air, and the data were compared with calculated pressure profiles using recent reaction kinetic information obtained from shock tubes. Good agreement between experiment and calculation was found when the flow was steady and no oscillations were present, indicating that the kinetics which govern the chemical reactions in shock tube experiments can be reproduced with the standing-wave experiment. Wall effects are evaluated. In addition, a semi-empirical analysis was made of the ignition delay and recombination, with the assumption that the two-body reactions are essentially in equilibrium during the slower recombination period. The mathematics of this approach is simple and is potentially useful with machine computations involving chemistry and mixing, or chemistry and aerodynamics. Finally, a short experiment with methane combustion in the tube produced similar phenomena, indicating that the method may be useful for determining rates of heat release for gases where little is known of the kinetics. Author (TAB)

N67-39925*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
PRECISION FLOW MEASUREMENT TECHNIQUES FOR LOW THRUST AUXILIARY PROPULSION LIQUID ROCKETS
Daniel J. Grant Aug. 1967 13 p refs
(NASA-TM-X-55967; X-734-67-440) CFSTI: HC $3.00/MF $0.65 CSCL 21H

The techniques required to obtain better precision in the measurement of fuel consumption of small thrusters (monopropellant and bipropellant 0.5 to 5.0 lbf thrust engines), using commercially available impeller wheel meters for steady flow and an in-house developed photometric device for pulsed flow, are described. By proper use of these devices, propellant flow consumption data accuracies of better than 1% can be achieved. Flow measurement requirements are considered for both steady and pulsed firing modes, for specific impulses of 150 to 350 lbf-seconds per lbm, and O/F ratios from 1 to 2. Frequency standards are used to correlate test stand data with laboratory calibrations of impeller flowmeters. Fluid dynamic simulation is obtained by selecting inert fluids whose kinematic viscosities are approximately those of the propellants. Anomolous behavior demonstrated during calibrations indicate that normal turbine meter frequency-viscosity characterizations are not applicable to impeller wheel units. The design, development, and preliminary testing of a photometric device for pulsed mode flow measurements is discussed. The initial models are applicable to a thrust range of 1/2 to 25 lbf. Author

N67-39948# California Univ., Berkeley. Thermal Systems Div.
PERFORMANCE OF AMMONIA-FIRED GAS-TURBINE COMBUSTORS
D. T. Pratt Aug. 1967 35 p refs
(Contract DA-04-200-AMC-791(X))
(TS-67-5; TR-9; AD-657585)

A theoretical and experimental program was undertaken to investigate scaling and combustion in gaseous ammonia-fired gas turbine combustors. Theoretical analysis of performance and scale test data previously performed strongly indicates that the final size chosen for an operating gas turbine is performance-limited almost equally by chemical reaction kinetics (residence time) and by turbulent diffusion or mixing processes (velocity or Reynolds number). Experimental results confirmed that a small-diameter combustor is chemically rate-limited at pressures very slightly less than the minimum previously reported, and becomes limited almost equally by chemistry and mixing at higher pressures. The fundamental problem with utilizing gaseous ammonia as a turbine fuel is certainly the relatively slow (compared to hydrocarbon

fuels) chemical reaction between ammonia and air. As air flow is reduced, to allow sufficient residence time for the reaction to progress, diminished Reynolds number effects lead to less efficient mixing. This in turn leads to decreased combustion efficiency. The only apparent solutions (apart from chemical enrichment by cracking or use of additives) are to use a smaller fuel nozzle orifice to create a more vigorous fuel jet in the primary zone, and to use two or more combustors in parallel rather than build a single larger combustor. TAB

N67-40107*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SOME DYNAMIC CHARACTERISTICS OF AN ELECTRON-BOMBARDMENT ION THRUSTOR

Eugene V. Pawlik, Shigeo Nakanishi, and Harvey R. Algeri Washington, NASA, Oct. 1967 52 p refs

(NASA-TN-D-4204) CFSTI: HC $3.00/MF $0.65 CSCL 21C

The experimental dynamic characteristics are examined for a 10-centimeter-diameter electron-bombardment ion thrustor. These dynamics were obtained by imposing perturbations on the various input parameters while operating at the design point. Data are presented for both refractory metal and oxide-coated cathodes. The time constants associated with the cathode heater and the propellant flow were found to be significant, in some cases of the order of several seconds. Some low-frequency (100 to 1000 Hz) effects on the ion-beam current and the cathode-emission current were observed for both the discharge voltage and magnetic-field perturbations. A critical frequency phenomenon within the ion-chamber plasma seemed to exist near 400 hertz. Author

N67-40119# National Research Council of Canada, Ottawa (Ontario). Engine Lab.

REMARKS ON THE MEASUREMENT OF EXHAUST GAS FLOW

J. J. Samolewicz and F. Rueter Jun. 1967 26 p refs

(ME-222; NRC-9716) CFSTI: $3.00

The exhaust flow from a free-piston gasifier was measured by a conventional method, using a standard orifice or nozzle. It was observed that fouling of the measuring devices falsifies the readings. The deviation from the true flow for the nozzle is opposite to that for the orifice. An explanation of the observed behaviour is offered, and a method for correcting the readings suggested. Author

N67-40128*# Rocketdyne, Canoga Park, Calif.

DUAL TURBOPUMP LIQUID HYDROGEN FEED SYSTEM EXPERIENCE

S. V. Gunn and C. Dunn Oct. 1967 29 p Presented at the 9th Liquid Propulsion Symp., St. Louis, 25–27 Oct. 1967

(Contracts SNP-2; NASw-347; NASw-1210)

(NASA-CR-89644) CFSTI: $3.00 CSCL 21H

Experience in the design and development of liquid hydrogen feed systems utilizing two turbopumps operating in parallel is described. The pumps are supplied with liquid hydrogen from a common inlet and discharge into a common duct; the turbines also are supplied with turbodrive gases from a common inlet. Two system configurations were designed, developed, and delivered: one having dual Mark 9 turbopumps and one having dual Mark 25 turbopumps. Component and system performance, and dynamic characteristics of the systems are described. Development tests have proved the practicality of parallel dual, liquid hydrogen turbopump operation. The two units operate with complete hydrodynamic stability, sharing the hydraulic load equally, and no detrimental mechanical interactions have been found. Dual turbopumps offer the potential of emergency, single pump operation. The current feed system has a check valve in each pump discharge prior to the common header, and the potential for such emergency operation is being evaluated. Author

N67-40132* Marquardt Corp., Van Nuys, Calif.

SPU PROGRAM REVIEW

Dec. 1964 30 p

(Contract NAS9-857)

(NASA-CR-89609) CSCL 21H

Engineering development efforts on the SPU-2A-1 engine and components, and on improving engine reliability, efficiency, and endurance are discussed. Design work on the SPU-2A-1 engine, the SPU-2A-2 roller bearing engine, the SPU-3 roller bearing engine with propellant system, high BMEP pistons, propellant pumps, and flat poppet injector valves is reported. Engine performance, sizing, and durability analyses are mentioned. Four basic cooling systems of the SPU engine are described. These systems include a circulating coolant with space radiator, a circulating coolant with water boil-off, gas refrigeration with space radiator, and vapor compression refrigeration with space radiator. R.N.A.

N67-40156*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EXPERIMENTAL VERIFICATION OF A DOUBLE-DEAD-TIME MODEL DESCRIBING CHUGGING IN LIQUID-BIPROPELLANT ROCKET ENGINES

John R. Szuch and Leon M. Wenzel Washington, NASA, 1967 12 p refs Presented at the 4th Combust. Conf., Menlo Park, Calif., 2–13 Oct. 1967; Sponsored by the Interagency Chem. Rocket Propulsion Group

(NASA-TM-X-52362) CFSTI: HC $3.00/MF $0.65 CSCL 21H

Stability limits were determined, experimentally, for a 2-inch diameter rocket engine. Liquid oxygen and gaseous hydrogen were the propellants. Boundaries were determined for two engine configurations: a chamber pressure of 650 psia, contraction ratio of 16.8, and a chamber pressure of 300 psia, contraction ratio of 8.4. The oxidant-fuel weight ratio was maintained at 5.0 with a characteristic length of approximately 95 inches. For comparison with experimental data, stability boundaries were generated on the analog computer, using the chugging model proposed by the authors and values of combustion delay, as determined from an existing vaporization model. Experimental and computer data agreed with regard to observed chugging frequencies and boundary shape. Discrepancies in boundary location (required injector pressure drops) were attributed to a high combustion noise level caused by the injection system used. The proposed model is further supported by noting observations made on several large-scale engines. Author

N67-40221*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SOME INJECTOR ELEMENT DETAIL EFFECTS ON SCREECH IN HYDROGEN–OXYGEN ROCKETS

Ned P. Hannum and E. William Conrad Washington, NASA, 1967 8 p refs Presented at the 4th Combust. Conf., Menlo Park, Calif., 2–13 Oct. 1967; Sponsored by the Interagency Chem. Rocket Propulsion Group

(NASA-TM-X-42363) CFSTI: HC $3.00/MF $0.65 CSCL 21H

An experimental investigation was conducted to learn more about how certain specific details of a concentric tube injection element effect the screech characteristics of a hydrogen–oxygen rocket. The five variables investigated were (1) injection angle, (2) oxidizer tube blunt base thickness, (3) oxidizer tube recess and extension, (4) oxidizer tube-annulus concentricity, and (5) element size or thrust-per-element. Tests were made using a 10.77-inch diameter heat-sink combustor at nominally 300 psia chamber pressure. The effects of the element detail changes on screech are summarized by first noting that these modifications resulted in changes in injector differential pressure even though the physical injection area was constant for all similar tests. Second, changes resulting in increased injector differential pressure produced improved

screech stability. These data trends were compared with a hydrogen flow response model and were found to be in agreement. Author

N67-40314*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SOLAR SAILS—A REALISTIC PROPULSION FOR SPACECRAFT
Mgr. Urbanczyk Redstone Arsenal, Ala., Redstone Sci. Inform. Center, 2 Aug. 1967 16 p Transl. into ENGLISH from Astronautyka (Poland), v. 8, no. 3, 1965 p 20–23 Prepared jointly with Army Missile Command
(NASA-TM-X-60560; RSIC-694) CFSTI: HC $3.00/MF $0.65 CSCL 21

Proposals for using the pressure of sunlight to propel spacecraft are reviewed, and three fundamental conditions are stipulated as necessary for the functioning of a solar sail. These are: (1) The spacecraft must be taken outside the gravity field of the mother planet by some other means of propulsion. (2) The ratio of the force developed on the sail surface to its surface density must be sufficiently large. (3) The orientation of the sail in the direction of the incident rays and with regard to the proposed course must be assured. The theory of solar sail is outlined. It is shown mathematically that the condition of attaining real interaction with the sun rays is to assure that the sail has the largest possible surface area and the lowest mass. These parameters determine whether at a given distance from the sun the sail will predominantly be the subject of radiation or gravitational forces. It is concluded that vehicles equipped with solar sails may be able to move in interplanetary space within certain limits, and that trips will be shorter than with classical propulsion systems. M.G.J.

N67-40342# Air Force Missile Development Center, Holloman AFB, N. Mex. Directorate of Test Track.
CRITERIA FOR SELECTING SOLID ROCKET MOTORS AS TRACK TEST PROPULSION
Hans J. Rasmussen Jun. 1967 47 p refs
(MDC-TR-67-76; AD-658841)

Closed form solutions of the simplified equation of motion of a rocket sled are used to define specific characteristics governing the applicability of individual solid rocket motors for track test propulsion purposes. Some of the interactions between motor performance parameters, sled design considerations, and track length constraints are reviewed. Criteria are developed for determining applicability ranges and performance limits of various rocket units, and to arrive at a basis for comparing the relative cost effectiveness of competing motors for rocket sled operation. Author (TAB)

N67-40432*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
AN INVESTIGATION OF THE USE OF ACOUSTIC ENERGY ABSORBERS TO DAMP LOX/RP-1 COMBUSTION OSCILLATIONS
Curtis R. Bailey Washington, NASA, Nov. 1967 36 p refs
(NASA-TN-D-4210) CFSTI: HC $3.00/MF $0.65 CSCL 21B

The effectiveness of acoustic energy absorbers in damping LOX/RP-1 combustion oscillations was investigated. Test firings were conducted using both cooled and uncooled absorbers in a 4000-pound thrust combustion chamber. Combustion oscillations, which had been consistently severe without the liners, were effectively damped when the liners were installed. Oscillations resulting from bomb-induced disturbances within the chamber were also effectively damped. A liner one-half as long as the combustion chamber and positioned at the injector end was as effective as the full-length liner. A sample absorber calculation is presented and absorber design procedures are outlined. The effects of variations in design assumptions are discussed, and it is concluded that these effects, plus the lack of a proven design procedure, preclude the accurate calculation of the absorption coefficient. Author

29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

N67-39811 Air Force Cambridge Research Labs., Bedford Mass.
THE USE OF GROUND LEVEL NEUTRON MONITORS IN A REAL TIME SOLAR PROTON MONITORING NETWORK
M. A. Shea *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 110–118 refs (See N67-39802 24-20)

During the past solar cycle, neutron monitors were a prime sensor for obtaining information relative to large solar particle events as these sensors recorded increases of the order of 100% during a sudden influx of solar-flare-associated protons with energies greater than 400 MeV. The data from these sensors were usually analyzed long after the event had occurred but the monitors were also utilized as a local alarm to initiate other experiments such as balloon launchings. It is planned to integrate several of these sensors into a monitoring network by the immediate transmission of the output data to a central collection agency and to use a computer to examine the data in real time to detect unusual deviations from the normal cosmic-ray intensity. Such a real time network should be capable of providing the first positive confirmation available from ground level sensors of the presence of high energy solar particles in the immediate vicinity of the earth. The concepts and plans for the implementation and operation of this type of monitoring network are presented. Author

N67-39820 Weather Wing (4th), Cheyenne, Wyo.
TECHNIQUES FOR PREDICTION OF SOLAR FLARES AND ENERGETIC PARTICLE EVENTS
Donald T. Sherry *In* Air Weather Serv. Tech. Exchange Conf. Jul. 1967 p 202–206 (See N67-39802 24-20)

To forecast solar flares, an activity level designator chart was designed to give the forecaster the percentage probability for an importance two or greater solar flare within 24 hours for a selected region. Significant known parameters, which are flare-related, are contained in six sections, with each considered as an independent precursor for a major flare. Each parameter is weighted and assigned index numbers across the top of each section. The index numbers, when totaled, correspond to a percentage probability for a major flare within 24 hours. For forecasting energetic particle events, a worksheet is used to evaluate solar regions prior to the occurrence of a proton flare. For postflare evaluation, the exact statistical percentage probability of detectable protons at the earth's surface for each parameter is listed. M.G.J.

N67-39891# Los Alamos Scientific Lab., N. Mex.
MEASUREMENTS OF SOLAR X-RAY EMISSION FROM THE IONS CARBON VI AND NITROGEN VII
W. Doyle Evans (Ph.D. Thesis—New Mexico Univ.) 27 Jul. 1967 167 p refs
(Contract W-7405-ENG-36)
(LA-3729) CFSTI: HC $3.00/MF $0.65

Two identical instrument packages containing X-ray crystal spectrometers were flown aboard Nike–Tomahawk sounding rockets launched from Kauai, Hawaii, on August 8 and 11, 1967. Each package contained eight curved crystal, nonscanning spectrometers focused for selected wavelengths of the solar spectrum between 19 and 34 Å. During the high altitude portion of the flight the instrument axis was aligned toward the sun by an attitude control system. Four of the spectrometers used lead stearate soap film analyzers. Three were focused for the Lyman-α, -β, and -γ lines of C VI. The fourth was focused to obtain a measurement of the continuum intensity at 26.0 Å. Three spectrometers using KAP crystals were focused for the first three lines of the N VII Lyman series. The eighth spectrometer had the crystal replaced by a polished aluminum surface to test the sensitivity of the instruments to scattered ultraviolet light. Data were obtained from all stations on the first flight. On the second flight two of the KAP spectrometers failed, probably because of broken crystals. The count rates in all stations were essentially constant during the entire five minute period that the packages were above the atmosphere. On both flights excellent data on atmospheric absorption were obtained during the reentry portion of the flight. From the data of the first flight, intensities of 1.8 and 0.5×10^{-3} erg/cm^2-sec were determined for the N VII Lyman-α and -β lines respectively. The X-ray flux at 19.83 Å was interpreted as continuum radiation with an intensity of 5×10^{-3} erg/cm^2-sec-Å. The expected line structure for the C VI Lyman series was not observed. Because of an inconsistency in the absorption data it was suspected that the stearate stations were sensitive to X-ray wavelengths outside the expected instrumental resolution. Laboratory measurements were made of the specular reflection of long wavelength X-rays from lead stearate crystals. For those spectrometers focused on the weaker lines and the continuum, specularly reflected X-rays from the 40 to 120 A region almost certainly introduced large errors. The measurement of the strong C VI Lyman-α line was less seriously affected. When a correction was made for the specular reflection the intensity of this line was found to be 2.9×10^{-2} erg/cm^2-sec on August 8 and 2.2×10^{-2} erg/cm^2 sec on August 11. The continuum intensity at 26.0 Å was 6×10^{-3} and 4×10^{-3} erg/cm^2-sec-Å on the two days. Author (NSA)

N67-39911# Texas A&M Univ., College Station.
A SELF-CONSISTENT STUDY OF EARTH'S RADIATION BELTS
John Baker and James Hurley [1963] 15 p refs Prepared jointly with Calif. Univ., Davis
(Grant NGR-05-004-006)
(NASA-CR-89563) CSCL 04A

In most work on the dynamical equilibrium of the Van Allen Belts it is assumed that the plasma is tenuous, i.e. one neglects second order effects such as the magnetic field generated by the particles in the belt compared to the geomagnetic field. It would seem from the results of these calculations that this is not a good approximation and that the plasma energy/vol. is comparable to the geomagnetic energy/vol. In the present work the radiation belts are treated self-consistently. In particular the question of how much plasma could be trapped in the belts if an unlimited source were present is considered. Judging from a preliminary calculation it would seem that the Van Allen Belts are saturated. Author

N67-39983 Institute of Physical and Chemical Research, Tokyo (Japan). Cosmic Ray Lab.
CATALOGUE OF COSMIC RAY DATA, JULY 1, 1967–MAY 31, 1967
31 May 1967 30 p

A compilation is presented of cosmic ray intensities submitted from observatories all over the world by May 1967, including meteorological data. The catalogue is divided into several parts according to the instruments used and components observed. The station in each part is arranged in alphabetical order of country names. Data from these stations are reported normally in the form of monthly tables. The elements are in form of hourly or bihourly values. In addition to the one sheet of observed cosmic ray data, pressure data are also submitted. Author

N67-40053# Mullard Research Labs., Reigate (England).
SCIENTIFIC EXPERIMENTS IN ESRO SATELLITE PROJECT TD-1
A. P. Willmore Paris, ESRO, Mar. 1967 51 p
(ESRO-SN-65) CFSTI: HC $3.00/MF $0.65

The scientific objectives and some of the main technical features of the experiments on the TD-2 satellite are described. Three experiments (S-39, S-106, S-126) will be solar-pointing, for the study of solar X-ray and UV-radiation. S-118 is also sun-pointing but is aimed at obtaining information about the O_2 concentration in the higher atmosphere from absorption measurements. S-97 will study light emission in the atmosphere in several separate lines. Experiments S-45 and S-80 will make direct measurements of ionospheric and atmospheric parameters; the first is a probe for measurement of positive ion density, temperature and composition and the second is a neutral-particle mass spectrometer. Experiments S-85 and S-94 are for observation of trapped and precipitated particles; the first will concentrate on low-energy electrons at lower altitudes, whereas the second will study auroral-zone phenomena. Experiments S-99 and S-103 will both observe high-energy solar galactic particles. Author (ESRO)

N67-40126*# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.
INVESTIGATION OF ENERGETIC ELECTRON INTENSITIES IN THE EARTH'S OUTER RADIATION ZONE WITH OGO 1
H. Kent Hills (M.S. Thesis) Aug. 1967 117 p refs
(Contract NAS5-2054)
(NASA-CR-89652) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Observations of intensities of outer zone electrons obtained with instrumentation borne on the earth-satellite OGO 1 during the period September through December, 1964, are presented. Omnidirectional intensities near the magnetic equatorial plane are given for electrons of energy E>40 keV, E>130 keV, and E>2 MeV, and are characterized by short-term variations superimposed upon an over-all long-term decrease. The pitch angle distributions of electrons (E>40 keV and E>130 keV) may be approximated by the function $\sin^n\alpha$ with n generally found to be less than or about unity throughout the outer zone ($3\leq L\leq 7$). Computations of the effects of geomagnetic storms upon the distribution of intensities of these electrons with energies above the detector thresholds are summarized. Adiabatic motions are shown to be capable of causing large temporal variations in electron intensities during a magnetic storm. Author

N67-40196*# Scientific Translation Service, La Canada, Calif.
ON THE POSSIBLE MECHANISM OF CHROMOSPHERIC FLARE EMISSION [O VOSMOZHNOM MEKHANIZME SVECHENIYA KHROMOSFERNYKH VSPYSHEK]
E. Ye. Dubov Washington, NASA, Oct. 1967 14 p refs Transl. into ENGLISH from Izv. Krymsk. Astrofiz. Observ. (Moscow), v. 29, 1963 p 86–98
(Contract NASw-1496)
(NASA-TT-F-11287) CFSTI: $3.00 CSCL 20I

It is shown that energy production due to ionization losses of fast particles, originating on the sun, is sufficient to explain flare emission and that heating of the gas should take place during the relaxation time of energy balance in the flare. The dependence

of ionization energy losses of fast particles on time is computed on the basis of existing conceptions on the spectra of fast particles. It is shown that this dependence is in agreement with the photometric curves in H_α obtained for flares. It has also been found that the emission increase in the H_α and L_α lines during flares should not be observed simultaneously. Author

N67-40247# Brookhaven National Lab., Upton, N. Y.
MOMENTUM SPECTRUM AND CHARGE EXCESS OF COSMIC RAY MUONS AT LARGE ZENITH ANGLES
Henry Kasha, C. B. J. Hawkins (Yale Univ.), and J. R. Stefanski (Yale Univ.) [1966] 10 p refs Presented at the 10th Intern. Conf. on Cosmic Rays, Calgary, Alberta
(BNL-11545; CONF-670628-3) CFSTI: HC $3.00/MF $0.65

A large momentum spectrograph with 100 cm^2 sr aperture was used to measure the momentum spectrum and charge excess of cosmic-ray muons at zenith angles close to 75°. Preliminary results based on a small sample of events agree well with available data. Author (NSA)

N67-40390# Brookhaven National Lab., Upton, N. Y.
SEARCH FOR PARTICLES WITH CHARGE 2/3e IN COSMIC RAYS
Henry Kasha, R. C. Larsen, L. B. Leipuner, and R. K. Adair (Yale Univ.) [1967] 11 p refs Presented at the 10th Intern. Conf. on Cosmic Rays, Calgary, Alberta
(BNL-11544; CONF-670628-2) CFSTI: HC $3.00/MF $0.65

The flux of particles with a charge equal to 2/3 of the electron charge which reach sea level from the vertical with relativistic velocities was found to be less than 2.7×10^{-10} cm^{-2} sr^{-1} sec^{-1} at the 90% confidence level. The particles were identified through their characteristic energy loss in a 48-counter hodoscope. The result seems inconsistent with a model of hadrons as being a composite of quarks. Author (NSA)

N67-40579*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
PROPOSAL FOR GALACTIC AND SOLAR COSMIC RAY STUDIES ON OGOs E AND G
V. K. Balasubrahmanyan, D. E. Hagge, G. H. Ludwig, and F. B. McDonald Feb. 1964 23 p
(NASA-TM-X-55989; X-611-64-37) CFSTI: HC $3.00/MF $0.65 CSCL 20H

An integrated set of three detectors is proposed to study the properties of the galactic and solar cosmic rays. (1) A double-scintillator Cerenkov telescope measures the charge and differential energy spectra of the individual nuclear constituents of charge Z=1–20 in the range 100 MeV/Nuc to 1200 MeV/Nuc and the integral flux greater than 1200 MeV. (2) An E vs dE/dx detector for electrons of 1–10 MeV and H, D, T, He^3, and He^4 and Z=3–20 in the 15–75 MeV/Nuc range. (3) A low energy solid state detector with anticoincidence cup proton .4–8 MeV and Helium 2–8 MeV. The experiment parameters are listed as: 21.9 lbs weight, 4.5 watts power, and 8"×8"×8" size. The spacecraft main body is mounted on the side looking away from the earth, and the telemetry requirement is 8 digital words in the main commutator in each of the two equipment groups. Author

30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

N67-39402*# Massachusetts Inst. of Tech., Cambridge.
LUNAR SOIL ENGINEERING AND ENGINEERING GEOLOGY, JULY 1–31, 1967
T. William Lambe and James K. Mitchell (Calif. Univ., Berkeley) 20 Oct. 1967 18 p Presented at the Conf. on Lunar Exploration and Sci., Santa Cruz, Calif., 31 Jul.–13 Aug. 1967
(Grants NsG-496; NSR-05-003-189)
(NASA-CR-81178) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The recommendations for the development of a long-range program in soil and rock engineering for support of lunar exploration and science are presented. The goals are identified as being the prediction and quantitative determination of soil and rock properties, development of analytical techniques, and the utilization of lunar environmental conditions for the understanding of terrestrial soil and rock behavior. The problems are listed, and the engineering program is outlined. Tabulated data are given on soil and rock properties, methods for measuring the properties, and test methods for acquisition of data for property evaluation. N.E.N.

N67-39413*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
LUNAR SURVEY PROBE UTILIZATION STUDY Summary Report
13 Oct. 1967 15 p refs
(Contract NAS7-100)
(NASA-CR-89537; JPL-760-12) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The study to utilize the unmanned lunar survey probe (LSP) in manned and unmanned programs is summarized. The limitations are identified, and applications are mentioned for geological reconnaissance and determinations of lunar shape, mass, and core; heat flow; and the relationship between electromagnetic properties and its particle-and-field environment. The performance, guidance and control, and power for the delivery, deployment, and support systems are discussed. The major factors to be considered in selecting the best combination of modes are outlined. The probe concepts are compared, and the research and technology implications are mentioned. N.E.N.

N67-39458# Ohio State Univ., Columbus. Aeronautical and Astronautical Research Lab.
CHEMICAL KINETICS OF ENTRY INTO THE MARTIAN ATMOSPHERE Final Report
E. Stokes Fishburne, K. R. Bilwakesh, and Rudolph Edse Wright-Patterson AFB, Ohio, ARL, May 1967 47 p refs
(Contract AF 33(657)-8951)
(ARL-67-0113; TR-6; AD-657778)

The reactions between carbon monoxide and oxygen to form carbon dioxide have been examined in two separate experimental studies. In the first study a mixture of carbon monoxide and oxygen was introduced into a shock tube. The mixture then was heated by a shock wave and the rate of formation of carbon dioxide was determined. The carbon dioxide concentration was followed by observing the intensity of the infrared radiation at 4.25 mu emitted by the heated carbon dioxide. Rate constants were obtained. However, it was shown that if the amount of water vapor in the system was greater than 7 ppm the primary reactions were governed by the hydrogen-oxygen system of reactions. Hence, it was impossible to obtain reliable rate constants for the CO-O2 system of reactions. The elimination of such minute quantities of moisture is almost impossible. The second experimental study involved expanding a high temperature mixture of CO2, CO, O, and O2 through a supersonic expansion nozzle. From a measurement of the pressure profile down the nozzle the chemical state of the gas can be determined. Extensive computer programs were formulated for this phase of the investigation. Unfortunately the contract period came to an end at the conclusion of the calibration experiments. Hence, no information was obtained concerning the recombination of carbon dioxide. TAB

N67-39505# Aerospace Corp., El Segundo, Calif.
A STATISTICAL ANALYSIS OF YAW STEERING FOR SPACE MISSIONS, OCTOBER 1966–FEBRUARY 1967
J. M. Baker Jun. 1967 33 p refs
(Contract AF 04(695)-1001)
(TR-1001(2121-10)-1; SSD-TR-67-135; AD-657769)

By using a simple steering law, the amount of propellant required to steer to a particular plane in space is derived. A statistical formulation of the required characteristic velocity is presented, based on a prior knowledge of the yaw position and yaw velocity errors. From the numerical results for the typical missions given, it is shown that the required characteristic velocity is usually small. It is thus concluded that only a slight propellant saving would be achieved by using other proposed yaw steering laws. Author (TAB)

N67-39535# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
NEW INTEGRALS OF MOTION AND THE ORBITAL HISTORY OF THE MOON
C. L. Goudas Aug. 1967 17 p refs *Its* Mathematical Note No. 521
(D1-82-0633; AD-658220)

A discussion of the orbital past of the Moon is presented here, taking into account gravitational and dissipative forces. Author (TAB)

N67-39536# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
A NEW INTEGRAL IN THE RESTRICTED PROBLEM?
C. L. Goudas Apr. 1967 27 p refs *Its* Mathematical Note 523
(Contract Nonr-609(50); Grant AF-AFOSR-397-67)
(D1-82-0635; AD-658163)

Extensive numerical experiments involving integration of a few thousand periodic and non-periodic solutions of the planar restricted problem of three bodies indicate that the recently given new integral of the restricted problem defines the same hypersurface as the Hamiltonian, and as a result it is not an independent integral. Author (TAB)

N67-39566# Weather Wing (6th), Andrews AFB, Md.
THE NATURAL ENVIRONMENT OF A SATELLITE IN A SYNCHRONOUS CIRCULAR ORBIT
Henry W. Brandli Scott AFB, Ill., Air Weather Serv., Jun. 1967 62 p refs
(TR-192; AD-658014)

The current literature is reviewed and the natural environment at about 6.6 earth radii (from the center of the earth) is defined in terms of the thermodynamic variables, the geophysical variables, the electromagnetic radiation environment, the particle radiation environment, and the meteoroid environment. Author (TAB)

N67-39580*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
STABLE PERIODIC ORBITS ABOUT THE SUN PERTURBED EARTH–MOON TRIANGULAR POINTS
Ronald Kolenkiewicz and Lloyd Carpenter Oct. 1967 22 p refs
(NASA-TM-X-55981; X-643-67-484) CFSTI: HC $3.00/MF $0.65 CSCL 03C

A method of general perturbations utilizing trigonometric series is used to investigate motion in the vicinity of the triangular equilibrium point of the earth–moon system. The model used is that of the restricted problem of four bodies for the earth–moon–sun system. In this model the three principle bodies are periodic, coplanar, and obey the equations of motion. A stable, periodic, coplanar orbit is calculated. In the synodic system it appears elliptical in shape, having a semimajor axis of 90,000 miles and an eccentricity of 0.5. The minor axis is parallel to the earth triangular point line. The mean motion of the particle describing this orbit is synchronized with that of the sun such that their angular positions coincide closely whenever the particle crosses one of the axes of the ellipse. A second orbit is also calculated. This stable orbit is similar in size and shape, but 180 degrees out of phase with the first orbit. The calculation of a small unstable coplanar orbit near the triangular point is reported. Author

N67-39592# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
HARMONIC ANALYSIS OF THE SELENODETIC CONTROL SYSTEM OF THE DEPARTMENT OF DEFENSE
T. A. Bray and C. L. Goudas Jul. 1967 37 p refs *Its* Mathematical Note no. 518
(D1-82-0631; AD-658161)

The Department of Defense Selenodetic Control System 1966 (DOD-66) is expressed here in terms of spherical harmonics. The coefficients obtained are different from those obtained on the basis of all previous systems. The second zonal harmonic corresponding to the DOD-66 suggests the improbable hypothesis that the Moon is elongated along the axis of rotation and, in particular, that the polar diameter exceeds the equatorial diameter by about 1 kilometer. Author (TAB)

N67-39655# Virginia Univ., Charlottesville. Leander McCormick Observatory.
A STUDY OF THE EARTHLIGHT ON THE MOON Final Report, Apr. 1966–May 1967
D. Scott Birney, Jr. and David D. Meisel May 1967 155 p refs
(Contract DA-49-129-ENG-586)
(SP-67-201; AD-658168)

The observational theoretical and empirical problems of determining the contribution of earthlight to the night-time illumination on the moon have been considered in detail. A photographic survey program to determine the absolute intensity of the earthlight portion of the moon is described. An empirical phase curve relating the mean magnitude difference between the earth and the sun has been derived from visual photometry measurements. The problems of predicting the albedo of the earth as well as predicting the mean albedo of specific location on the lunar surface are reviewed. Theoretical and empirical determinations of the photometric function of the lunar surface are discussed. Tables and graphs of relative surface brightness under earthlight are presented for a number of locations on the moon. These include information about nine APOLLO sites as well as locations every 5 deg. of longitude and latitude between plus or minus 50 deg. longitude and latitude. The tables are for zero libration. Although the tables and graphs have been compiled under simplifying assumptions; instructions for making the necessary corrections to specific situations are discussed. TAB

N67-39669*# General Motors Corp., Santa Barbara, Calif. AC Electronics-Defense Research Labs.
ROVING VEHICLE MOTION CONTROL Quarterly Report, 1 Jun.–31 Aug. 1967
B. P. Miller, T. M. Corry, D. E. Johnson, R. J. Johnston, and J. E. Lingerfelt Sep. 1967 89 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951829)
(NASA-CR-89583; TR67-45) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The report analyzes roving vehicle missions on the moon and Mars from the standpoints that affect motion control, and six baseline missions are evolved. These missions are then analyzed to determine their implications upon system requirements, and general system configurations are developed for each of the six cases. The major problems of implementation are identified as data accumulation and data appraisal, and various approaches to these problems are discussed. An approach to the comparative evaluation of candidate systems is also described. Author

N67-39686# Martin Co., Baltimore, Md.
OBSERVATION SYSTEM BIAS ESTIMATION FROM SATELLITE OBSERVATIONS DIGITAL COMPUTER PROGRAM, VOLUME 2 Final Report, 1 Jun. 1966–31 May 1967
Karlis Minka, Jacques Fein, and Bruce E. Clemenz Aug. 1967 108 p refs
(Contract AF 19(628)-4167)
(ER-14627, Vol. 2; AFCRL-67-0439; AD-657811)

This program is based on the analytical work contained in Report AD-625 453. In addition, more details about the filtering equations concerning the bias estimation are reported in the appendix of this report. The general features, development, inputs and modes of operation of the program are discussed. In addition, a sample estimation of observation and station location biases is presented. Operating instructions and input/output descriptions and definitions are provided. All symbols used in the program are listed and defined in conjunction with Report AD-637 206. All additional or modified flow charts and subroutines which are not included in AD-637 206 are presented. The program is written in FORTRAN IV and machine language (MAP). Double precision is used extensively. Revisions and modifications of the program reported in AD-637 206 are reported in the appendix. TAB

N67-39729* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
EARTH–VENUS TRAJECTORIES, 1973
Peter Feitis 28 Feb. 1967 28 p refs
(Contract NAS7-100)
(NASA-CR-89539; JPL-TM-33-342) CSCL 22C

The results of an analysis of Earth–Venus trajectories launched during the favorable launch period occurring in 1973 are presented. The data is based on the patched-conic approximation; i.e., the Earth–Venus trajectory consists of three distinct phases of two-body motion: (1) an escape hyperbola near Earth, (2) elliptical motion with respect to the Sun, and (3) a hyperbolic trajectory near Venus. Author

N67-39762* Boeing Co., Seattle, Wash. Aerospace Group.
VOYAGER SPACECRAFT SYSTEM TASK C SUMMARY Final Technical Report, Apr. 1966–Jul. 1967
Jul. 1967 38 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951111)
(NASA-CR-89733; D2-113584-1) CSCL 22A

Summaries are presented for the four studies completed during Phase IA of Task C of the Voyager spacecraft system program. These deal with developing a mission risk analysis technique, identifying most favorable orbits for Voyager Mars missions, developing the project configuration management program, and defining a conceptual liquid injection thrust vector control system for a modified Minuteman II second stage motor to meet Voyager TVC requirements. M.W.R.

N67-39763* Boeing Co., Seattle, Wash. Aerospace Group.
VOYAGER SPACECRAFT SYSTEM TASK C MISSION RISK ANALYSIS STUDY. VOLUME I: SUMMARY. VOLUME II: DEVELOPMENT. VOLUME III: HANDBOOK Final Technical Report, Apr. 1966–Jul. 1967
Jul. 1967 395 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951111)
(NASA-CR-89736; D2-113580-1; D2-113580-2; D2-113580-3) CSCL 22A

The Mission Risk Analysis Technique and the effort that led to its definition are reviewed. Designed to satisfy the study objective of defining a means for assessing and comparing risks associated with various proposed Voyager missions, the technique uses an iterative approach that involves a cyclic process of technique definition, demonstration, critique, redefinition, and demonstration. This iterative approach enabled several techniques to be defined and evaluated. The first iteration, a cost effectiveness approach, had major shortcomings. The second iteration resulted in a satisfactory technique, and the third and final iteration involved minor modifications to the technique defined in the second iteration. The selected technique involves identifying high risk areas at the subsystem, system, and mission levels; defining the cost, schedule, and performance consequences of these areas; translating the consequences into effects on the overall mission; and ordering the defined risk from most to least severe on the output table. Author

N67-39764* Boeing Co., Seattle, Wash. Aerospace Group.
VOYAGER SPACECRAFT SYSTEM TASK C ORBIT STUDY. VOLUME I: TECHNICAL APPROACH AND RESULTS Final Technical Report, Apr. 1966–Jul. 1967
Jul. 1967 768 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951111)
(NASA-CR-89731; D2-113581-1) CSCL 22C

Technical approach and results obtained during the study of orbits for the Voyager Mars flight spacecraft are reported in terms of development of scientific and engineering value functions, as well as the computer program and identification of the most favorable orbits. Mission and system aspects of the Voyager Mars program were reviewed to identify are orbit-dependent considerations, and value functions were developed for each of the 23 identified considerations. Weighting factors were determined and combined with individual value functions to formulate an overall value function. The analytical tool developed is a computer program called SCORE, for SpaceCraft Orbit Evaluator; and this tool includes an orbit generator program, auxiliary trajectory program, value function evaluator, and output and control programs. The SCORE program was used to evaluate 350 candidate orbits selected for four mission opportunities, and results are graphed. It is concluded that the value function technique can be applied to relate Voyager spacecraft scientific experiments and engineering considerations to mission and system parameters. M.W.R.

N67-39765* Boeing Co., Seattle, Wash. Aerospace Group.
VOYAGER SPACECRAFT SYSTEM TASK C ORBIT STUDY. VOLUME III: SCORE COMPUTER PROGRAM DESCRIPTION AND USERS MANUAL Final Technical Report, Apr. 1966–Jul. 1967
Jul. 1967 317 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951111)
(NASA-CR-89732; D2-113581-3) CSCL 22C

Computer program description and instructions, value function listings for each engineering and scientific consideration, and a sample printout for one complete orbital mission are presented in this users' manual for the Spacecraft Orbit Evaluator (SCORE) program for the Voyager project. Details are included for the control

program, orbit generator, auxiliary trajectory programs, value function programs, and plotting programs that comprise SCORE, which evaluates orbits in terms of their relative engineering and scientific values based on weighted sums of individual value functions.
M.W.R.

N67-39786* Boeing Co., Seattle, Wash. Aerospace Group.
VOYAGER SPACECRAFT SYSTEM TASK C CONFIGURATION DATA AND MANAGEMENT STUDY Final Technical Report, Apr. 1966–Jul. 1967
Jul. 1967 455 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951111)
(NASA-CR-89735; D2-113582-1) CSCL 22B

Various methods of providing indices of configuration identification data using automated data processing techniques are reviewed, and a system is recommended for use on the Voyager program. Included is a review of methods for providing actual data copies such as drawings, specifications, reports, and procedures. A recommendation is made for an aperture card system for reproducing drawings and a microfiche system for reproducing book form documentation, and a critique of configuration management procedures is included.
Author

N67-39846# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
ON THE THIRD INTEGRAL OF THE GALAXY
C. L. Goudas Aug. 1967 29 p refs *Its* Math. Note No. 522
(D1-82-0634; AD-658162)

It is shown here that the third integral of the galaxy, whenever its constant is conserved, defines the same surface as the Hamiltonian, and thus does not constitute any new integral, but a function of the already known integral of energy. In particular, the third integral and the Hamiltonian are found to possess collinear gradients, in accordance with Poincares theorem concerning the characteristic exponents in systems with multiple integrals.
Author (TAB)

N67-39866# TRW Systems, Redondo Beach, Calif.
MANNED EXPEDITION TO MARS: A SELECTIVE BIBLIOGRAPHY
L. R. Magnolia, comp. 18 Aug. 1967 10 p refs *Its* Spec. Lit. Surv. No. 31PR
(TRW-99900-6264-T001; AD-658997)

Books, articles in periodicals, and conference papers are listed alphabetically by author.
TAB

N67-39868*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
MARS THERMOPHYSICS
W. P. McNutt, Barbara Maye, and Nancy McHugh Redstone Arsenal, Ala., Redstone Sci. Inform. Center, 28 Sep. 1967 224 p refs Prepared jointly with Army Missile Command
(NASA-TMX-60552; RSIC-657) CFSTI: HC $3.00/MF $0.65 CSCL 03B

This bibliography contains approximately 500 annotated citations on the planet Mars published from the latter part of the nineteenth century through early 1967. The selected references are concerned only with the thermophysics of Mars and, specifically, with the results of experiments and analyses in those regions of the electromagnetic spectrum which relate to thermophysics. References concerning the possibility of life on Mars and space vehicle design and performance have been excluded.
Author

N67-39923*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ON A GENERALIZATION OF THE DEVELOPMENT OF THE DISTURBING FUNCTION
Jean Meffroy Sep. 1967 43 p refs
(NASA-TM-X-55968; X-641-67-442) CFSTI: HC $3.00/MF $0.65 CSCL 03C

The previous developments of the disturbing function of a first order general planetary theory involved commonly only one disturbing planet. They were performed by considering the inclination of the orbital plane of the disturbed planet on that of the disturbing planet or vice versa, that is to say by considering the mutual inclination and by referring the longitudes to the longitude of the ascending node of the disturbed or of the disturbing planet. In the present paper, we perform a more general development of the disturbing function by considering n planets instead of two ($n>2$), by referring the inclination of each of those n planets to a common fixed plane, by referring the longitudes to a common origin and by reducing the Fourier series of the principal part of the disturbing function to the sum of its $n(n-1)(p+1)/2$ first terms, the positive integer p being unspecified. The development of the principal part and that of the indirect part of the disturbing function are performed up to the fourth powers of eccentricities and the sines of inclinations and they could be easily extended to the eight powers required for the building of a complete first order general planetary theory.
Author

N67-39932*# Scientific Translation Service, La Canada, Calif.
FORMATION OF DUST PARTICLES IN A COMET ATMOSPHERE AS A RESULT OF GAS CONDENSATION [OBRAZOVANIYE PYLINOK V ATMOSFERE KOMETY V REZUL'TATE KONDENSATSII GAZA]
A. Z. Dolginov Washington, NASA, Oct. 1967 8 p refs Transl. into ENGLISH from Astron. Zh. (USSR), v. 44, no. 2, 1967 p 434–438
(Contract NASw-1498)
(NASA-TT-F-11329) CFSTI: $3.00 CSCL 03B

Consideration of gas condensation near a comet nucleus as a source of the formation of the entire dust component of the comet coma. It is maintained that available observational data do not discount the possibility of this origin of comet dust. A theory is proposed to explain the mechanism of the process. It holds that secondary gas molecules (C_2, CN, etc) are formed from the primary molecules of a comet nucleus (CH_4, NH_3, etc) and that the concentration and the number of collisions of these secondary molecules are sufficient for the formation of stable nuclei of a solid phase.
Author

N67-39960*# Volt Technical Corp., Washington, D. C.
ON LITHIUM CONTENT IN THE SPECTRA OF STARS OF T TAURUS TYPE AND IN COSMIC RAYS [O SODERZHANII LITIYA V ZVEZDAKH TIPA T TEL'TSA I V KOSMICHESKIKH LUCHAKH]
G. A. Guradzyan 18 Oct. 1967 6 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR, Ser. Astron., v. 176, no. 2, 1967 p 291–294
(Contract NAS5-12487)
(NASA-CR-89641; ST-ISA-CR-10659) CFSTI: $3.00 CSCL 03A

On the basis of earlier findings about the presence of lithium in T Tau-type stars the author establishes that the total number of lithium atoms in their atmospheres is at least $1 \cdot 10^4$ times greater than in that of the Sun. Drawing a parallel with the high lithium content in cosmic rays, it is hinted that T Tau-type stars may be lithium suppliers for the interstellar medium. To verify this, a line of study is suggested for determining the isotopic composition of cosmic rays, particularly in relation to the Sun.
Author

N67-39957* Boeing Co., Seattle, Wash.
LUNAR ORBITER III. POSTMISSION PHOTO SUPPORTING DATA
6 Sep. 1967 504 p refs
(Contract NAS1-3800)
(NASA-CR-66469; D2-100753-7) CSCL 22A

This volume, one of seven mission evaluation reports, describes and tabulates the photo supporting data for each of the Lunar Orbiter III photos based on postmission analysis of orbit, trajectory, and spacecraft performance factors. Concepts and methods employed to derive the data and other parameters for the Mission III photos are briefly discussed. Defined are the parameters contained in the photo evaluation computer program (EVAL), the version of the ephemeris data used, and the sources of input data required for computation of the photographic supporting data. Included are the input data not contained in other documents and the output listings of the EVAL computer program for each photo. K.W.

N67-39995*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NUMERICAL INTEGRATION OF ORBITS IN MULTIREVOLUTION STEPS
C. E. Velez Jan. 1967 22 p refs
(NASA-TM-X-55966; X-542-67-341) CFSTI: HC $3.00/MF $0.65 CSCL 22C

A predictor–corrector algorithm applicable to the numerical integration of an artificial earth satellite in multirevolution steps is reviewed. The multirevolution predictor and corrector formulas are developed to yield general recursive relations for the coefficients, which are similar to those for the Adams' integration formulas. In addition, the applicability of the algorithm to orbit calculations is demonstrated numerically. Author

N67-40004* Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
STUDY OF DUST DEVILS IN RELATION TO THE MARTIAN YELLOW CLOUDS Quarterly Progress Report, 1 Jun.–31 Aug. 1967
J. A. Ryan and F. F. Fish, Jr. 31 Aug. 1967 116 p refs
(Contract NASw-1670)
(NASA-CR-89578; QPR-1) CSCL 03B

A study is being conducted to determine whether dust devils could occur on Mars and be responsible for the observed yellow clouds. Emphasis is being given to field studies and during this period field data were obtained in the Mojave Desert of Southern California. Quantities measured were temperature as a function of height and time, background wind velocity, wind direction, pressure, dust devil diameter, dust column height, height of dust devil associated turbulence, and horizontal wind velocity inside the dust devil. Temperature measurements were initially taken up to 150 meters, but on occasion the temperature lapse rate remained superadiabatic above this height. Accordingly, measurements were extended up to 1540 meters above the surface using a light plane. The maximum dust devil velocity recorded to date was 45 km/hr under strongly superadiabatic conditions. Dust devil associated turbulence was found as high as 3600 meters above the surface and the maximum dust column height was 450 meters. The data demonstrate that a superadiabatic lapse rate is necessary for dust devil generation and their considerable vertical extent. Author

N67-40061# European Space Vehicle Launcher Development Organization, Paris (France).
FEASIBILITY OF GEOSTATIONARY BODIES AT ARBITRARY LATITUDE
E. Cambi Sep. 1967 7 p refs
(ELDO-TM-104) CFSTI: HC $3.00/MF $0.65

It has been shown elsewhere that a body can be kept geostationary at arbitrary latitude (other than equatorial) if a continuous thrust is available. This result was obtained through the use of a rather complicated analysis. This note discusses the feasibility of the proposal using elementary analytical tools. It is concluded that at useful latitudes the required acceleration is far too high to be practical in the present state of the technology. Author (ESRO)

N67-40153*# Lincoln Lab., Mass. Inst. of Tech., Lexington.
RADAR STUDIES OF THE MOON, VOLUME I Final Report
19 Oct. 1967 29 p refs
(Contract NSR-22-009-106)
(NASA-CR-89585) CFSTI: HC $3.00/MF $0.65 CSCL 03A

Observation of the mean properties of the lunar surface and their interpretations are considered. Radar cross sections were measured at 23 cm with high precision. Echo power versus delay measurements were made at 3.8 cm and 23 cm, and discussions are given on the polarized, depolarized and linearly polarized components. The ratio of the two principal backscattering coefficients for linearly polarized waves were also measured at both 3.8 and 23 cm. Radiometric observations of the polarization of the thermal emission across the lunar disk are described. Data indicate the lunar surface is gently undulating and is characterized by a mean slope of less than 10°. The uppermost surface layers have a relative dielectric constant not more than and probably less than 2.6. The polarization data were explained on the basis of scattering from rocks or pebbles. The backscattering at oblique angles of incidence appears to be direct measure of the surface density. N.E.N.

N67-40168*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
STATION CONTACT TIMES FOR APOLLO ORBITS WITH VARIABLE LAUNCH AZIMUTHS
F. O. Vonbun and W. D. Kahn 6 Mar. 1967 43 p refs
(NASA-TM-X-55965; X-500-63-85) CFSTI: $3.00 CSCL 22A

This paper presents graphs showing the times of contact of the Apollo spacecraft in its parking orbits. Orbit heights of 200 km (≈110 nmi) and 300 km (≈160 nmi) are considered. It is hoped that these graphs will help solve some of the tracking and communication tasks connected with orbits that have launch azimuths which change continuously as the launch time is delayed. The graphs show the contact times for different ground stations for one to six parking orbits that have launch azimuths which vary continuously from 73° to 110°. Author

N67-40188* Volt Technical Corp., Washington, D. C.
RAPID VARIATIONS IN EARTH'S SATELLITE DRAG AND PROPERTIES OF THE UPPER ATMOSPHERE [BYSTRYYE IZMENENIYA V TORMOZHENII SPUTNIKOV ZEMLI I SVOYSTVA VERKHEY ATMOSFERY]
D. I. Irgashev and V. E. Chertoprud 16 Oct. 1967 3 p refs
Transl. into ENGLISH from Astron. Tsirkuliar Akad. Nauk SSSR (Kazan), no. 439, 18 Aug. 1967
(Contract NAS5-12487)
(NASA-CR-89681; ST-AES-AI-10658) CSCL 22A

Reported are results of an autocorrelation and cross correlation analysis of rapid variations of Earth atmospheric density in the 165 to 215 km altitude range. Determinations are based on fluctuations of the variation rates of anomalous periods of eleven American satellites which are tracked by radar. Author

N67-40233*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE PROGRAMS SUMMARY NO. 37-46, VOLUME IV FOR THE PERIOD JUNE 1 TO JULY 31, 1967. SUPPORTING RESEARCH AND ADVANCED DEVELOPMENT
31 Aug. 1967 289 p refs
(Contract NAS7-100)
(NASA-CR-89567; JPL-SPS-37-46, Vol. IV) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Continuing research progress is briefly reported in the following areas: systems analysis; environmental requirements and simulation; spacecraft computers, power, and guidance and control; liquid and solid propulsion; telecommunications systems and elements; lunar and planetary sciences, science data systems, and physics; and engineering mechanics. N.E.N.

N67-40293*# American Science and Engineering, Inc., Cambridge, Mass.
ANALYSIS OF SOUNDING ROCKET DATA REGARDING CELESTIAL X-RAY SOURCES
H. Gursky, R. Giacconi, P. Gorenstein, and J. R. Waters x1967] 50 p refs
(Contracts NASw-1396; NASw-1284; Grant NsG-386; Contract AT(30-1)-2098)
(NASA-CR-89599; ASE-1408) CFSTI: HC $3.00/MF $0.65 CSCL 03A

Data are presented on the results obtained from an Aerobee sounding rocket containing an instrumented payload designed to stydy celestial X-ray sources with high angular resolution. The visible counterpart of ScoX-1, the strong X-ray source in Scorpio, was identified, and it was ascertained that the angular size cannot exceed 20". The angular resolution of the collimators used was about 40", and an aspect measuring system was employed that largely eliminated the possibility of systematic errors in location resulting from alignment errors. Techniques are described which permitted measuring the location of the source with a precision of about 1 arc minute. Optical identification is also discussed. The data obtained are theoretically assessed, and the possibility is explored that these celestial objects are members of the galaxy and may have a role in stellar evolution. M.G.J.

N67-40303# Dearborn Observatory, Evanston, Ill.
A STATISTICAL AND ASTROPHYSICAL INVESTIGATION OF EMISSION-LINE STARS AND PLANETARY NEBULAE IN THE SOUTHERN MILKY WAY Final Report
Karl G. Henize Sep. 1967 11 p refs
(Contract Nonr-1228(19))
(AD-658513)

The Principal Investigator visited Mt. Stromlo Observatory from September 1961 through June 1962 under the auspices of this contract to make observations of emission-line stars and planetary nebulae in the southern Milky Way which were discovered during a previous research program. Although many phases of data reduction were still not completed by the end of this extension, the work on the planetary nebulae was essentially completed. Author (TAB)

N67-40318* Farnham (Frank C.) Co., Philadelphia, Pa.
RESULTS OBTAINED WITH THE AID OF NIGHT CAMERAS. EXTRA-ATMOSPHERIC OBSERVATIONS OF ULTRAVIOLET RADIATION IN THE MILKY WAY IN WINTER [RESULTATS OBTENUS A L'AIDE DES CAMERAS NOCTURNES. OBSERVATIONS EXTRA-ATMOSPHERIQUES DU RAYONNEMENT ULTRA-VIOLET DANS LA VOIE LACTEE D'HIVER]
Washington, NASA, Oct. 1967 11 p refs Transl. into ENGLISH from the French
(Contract NASw-1497)
(NASA-TT-F-11234) CSCL 03A

The Milky Way was photographed in the near ultraviolet (2000–3000 Å) from stable platforms lofted outside the atmosphere on 11 January 1967 and 4 April 1967 using Kodak 103 aO–UV film. An optical description is given of the two special cameras, which combined a wide angle (120°) lens with a large (f/1) aperture and good brightness characteristics, and the photographic results are discussed and evaluated. A maximum magnitude of 7.5 was attained. Photos from the first launch revealed three nebulae with $\phi = 10° \times 20°$, centered around Sirius, Orion's Belt, and $\alpha = 6h\ 40m$, $\delta = +33°$ (near θ Gemini), and some 30 stars. Photos from the second launch showed more than 800 Population I stars. A catalog is in preparation supplementing the Morgan UBV classification for the new pass band 2400–3200 Å. A photograph is included from each of the two launches. Author

N67-40320* Earth Science Research Corp., Santa Monica, Calif.
STUDY OF SHAPE AND INTERNAL STRUCTURE OF MOON, UTILIZING LUNAR ORBITER DATA
Donald L. Lamar, R. M. L. Baker, Jr., and J. V. Lamar Oct. 1967 17 p refs
(Contract NSR-05-264-002)
(NASA-CR-89683; QPR-5) CSCL 03A

Comparison of the terms in a spherical harmonic expansion of the lunar gravity field derived from analyses of Lunar Orbiter data with similar terms in a lunar continentality function reveal that excess mass must underlie the maria. Density variations and internal structures which would lead to the observed garvity field are calculated for a rigid moon with a random lumpiness and a moon in isostatic equilibrium and thermal convection. It is found that either model of internal structure is consistent with the data. The density contrasts and dimensions for each model were found to be remarkably consistent for the $C_{2,0}$, $C_{2,2}$ and $C_{3,0}$ terms. The overall moment of inertia as determined from the orbiter data is still too poorly known to determine whether the moon is homogeneous or differentiated. Author

N67-40334# Eidgenössische Technische Hochschule, Zürich (Switzerland).
THE INNER STRUCTURE OF THE SOLAR CORONA [DIE INNERE STRUKTUR DER SONNENKORONA]
Harry Nussbaumer (Ph.D. Thesis) 1967 59 p refs In GERMAN; ENGLISH summary
(DISS-3931) CFSTI: HC $3.00/MF $0.65

A coronal model is given that explains the observed intensities of the green and red coronal line and their variations and also the observed line widths. The intensity-variations from equator to pole can best be explained by introducing an inhomogeneity-coefficient D. For a six month period in 1957/58 the average line intensities for different heliographic latitudes were taken from observations. A new explanation is given for the discrepancy between ionization-temperature and line width temperature. It is shown, that the joint effects of a radial expansion and a temperature gradient can change the line width more than the additive influences of these two effects would allow for. Although the fact that a difference in the green and red line width temperature may signify different places of origin of the green and red lines is not ruled out, it is demonstrated that this need not be the case. Author

N67-40336*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

SOME FLIGHT MECHANICS CONSIDERATIONS FOR THE VOYAGER MISSION

Clyde D. Baker, James C. Blair, and Wilton E. Causey 8 Sep. 1967 28 p

(NASA-TM-X-53654) CFSTI: $3.00 CSCL 22A

Four aspects of aero-astrodynamics studies of the Voyager mission are discussed. The four areas are: (1) the effects of Earth–Mars–Sun geometry on launch opportunities, (2) the influence of trajectory design requirements on the Voyager mission, (3) present performance capabilities of the Saturn V Voyager vehicle, and (4) the proposed launch vehicle load relief control system. Author

N67-40411*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

APPLICATION OF REDUNDANCY STUDY, VOLUME 4 Final Report

Lee E. Hauguane, Jr. 28 Jul. 1967 359 p Prepared for JPL

(Contracts NAS7-100; JPL-951112)

(NASA-CR-89703; VOY-CO-FR, Vol. 4) CFSTI: $3.00 CSCL 22B

Applications of redundancy to both the mission and spacecraft system levels of the Voyager program are considered, and the evolution of the mission configuration decision model is presented. Nominal probabilities, costs, and values are used for the decision model; with no attempt to determine the sensitivity of the resulting policies to these three nominal variations. For these values, an unmanned Mars project appears to offer the highest return of expected value. For 1971, a Mariner flyby with an atmospheric probe is suggested; for 1973, large surface landers with extensive television and physical experiment capability; and from 1975 through 1981, landers of the VBL class. Aspects of spacecraft system redundancy selection that are detailed include the mission outcome and values, system definition and description, hardware failure modes and mission effects, and system optimization. For mission configuration selection, details are presented of a pilot study; potential mission configurations; decision, probability, cost, and value models; and the SPAN computer programs. M.W.R.

N67-40417*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

DATA MANAGEMENT STUDY, VOLUME 5. APPENDIX F: CONTRACTOR DATA PACKAGE TEST (TE) AND MISSION OPERATIONS (MP) Final Report

B. C. Daniels and J. Kotzar 28 Jul. 1967 124 p Prepared for JPL

(Contracts NAS7-100; JPL-951112)

(NASA-CR-89710; VOY-CO-FR, Vol. 5, Append. F) CFSTI: $3.00 CSCL 22D

Data management aspects of test and mission operations for the Voyager spacecraft are detailed in this contractor data package, which includes data requirement descriptions, documentation relationship trees, and frequency and phasing charts. Test data to evaluate development objectives are plans and procedures for design verification, qualification, reliability demonstration, and flights. Both checkout procedures as well as flight operations and reliability demonstrations of Voyager hardware are included. Mission operations reflect areas such as long-range planning for the tracking network and mission support, profile launches and mission objectives, and personnel requirements. M.W.R.

N67-40419*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

DATA MANAGEMENT STUDY, VOLUME 5. APPENDIX H: CONTRACTOR DATA PACKAGE LOGISTICS AND SUPPORT (LS) Final Report

B. C. Daniels and J. Kotzar 28 Jul. 1967 97 p Prepared for JPL

(Contracts NAS7-100; JPL-951112)

(NASA-CR-89712; VOY-CO-FR, Vol. 5, Append. H) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Logistics concepts, programming, planning, and control related to such areas as transportation, supply, communications, maintenance, and support facilities are covered in the contractor data package for Voyager logistics and support. The contractor flow diagrams indicate the logistics support activities during all the phases of the Voyager project; and documentation relationship trees, data requirement descriptions, and frequency and phasing charts required for logistics and support are detailed. M.W.R.

N67-40429*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.

ABSORPTION COEFFICIENTS OF O_4 AT OXYGEN WINDOWS

Shardanand Washington, NASA, Nov. 1967 8 p refs

(NASA-TN-D-4225) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The attenuation coefficients of oxygen have been measured at O_2 windows. The attenuation does not follow Beer's law at four windows namely, 1215.7, 1187.1, 1157.0, and 1108.3 Å. The observed linear increase in attenuation coefficients with rise in gas pressure is ascribed to the formation of O_4 molecules. The absorption coefficients of O_4 are determined. Author

N67-40434* Boeing Co., Seattle, Wash.

LUNAR ORBITER IV POSTMISSION PHOTO SUPPORTING DATA

21 Sep. 1967 465 p

(Contract NAS1-3800)

(NASA-CR-66472) CSCL 02C

A brief discussion of the general concepts and methods employed to derive the photo supporting data and other parameters for the mission IV photos are presented in the two main sections of this document. The supporting data information section defines the parameters contained in the photo evaluation computer program (EVAL), the version of the ephemeris data used, and summarizes the sources of input data required for computation of the photographic supporting data. The supporting and evaluation data section includes the input data not duplicated within other documents. Also included are the output listings of the EVAL computer program for each photo. Author

N67-40437 Defence Research Telecommunications Establishment, Ottawa (Ontario).

ALOUETTE 1 IONOSPHERIC DATA INTERPOLATED N(h), VOLUME 3

1 Aug. 1967 472 p

The calculation of real height profiles yields electron number densities at heights which vary from profile to profile and which depend on the scaling of the ionogram. It is useful, however, to determine the number density at specific heights to study the variation in density at constant heights. In this series of publications the electron number density at heights from 1000 km to 250 km in increments of 50 km are tabulated for those profiles published in the DRTE series of Alouette I Ionospheric Data—N(h) Profiles. The number densities at these heights are determined from the data which comprise the DRTE series of N(h) profiles by linear interpolations in plasma frequency. The tabulations are preceded by an index which indicates the data available. Author

N67-40438*# Smithsonian Astrophysical Observatory, Cambridge, Mass.

CONTAMINATION OF MARS

Carl Sagan, Elliott C. Levinthal, and Joshua Lederberg Jun. 1967 18 p refs

(Grants NGR-09-015-023; NsG-81-60)

(NASA-CR-89768) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The present sterilization standards adopted by the Committee on Space Research are reviewed, and published arguments recommending relaxation in the standards are refuted. The probability of release of entrapped organisms from inside the spacecraft, the probability of reproduction of a terrestrial microbe on Martian surface, and the possibility of terrestrial microorganisms already being deposited by Soviet spacecraft are considered. Emphasis is placed on new evidence in the areas of release, survival, dissemination, and growth of terrestrial microbial contaminants. N.E.N.

N67-40440*# National Aeronautics and Space Administration, Washington, D. C.

WEIGHTLESSNESS

1967 4 p refs

(NASA Facts S-5/8-67) GPO: $0.05 CSCL 22A

The basic principles of weightlessness are explained. The discussion points out that weightlessness does not mean the absence of gravity, but rather, that a weightless object is subject to gravity plus some other effect which balances the gravitational force. Weightlessness produced by an aircraft flying a parabolic arc is described as well as its effects and problems in manned space flight. The biosatellite program, intended to measure the effects of weightlessness on animals, cells, and plants, is briefly mentioned. A facility for simulating zero gravity is described. R.N.A.

N67-40462*# Stanford Univ., Calif.

RELATIONSHIP OF PLANETARY QUARANTINE TO BIOLOGICAL SEARCH STRATEGY

E. C. Levinthal, J. Lederberg, and Carl Sagan (Harvard Univ., Cambridge, Mass.) [1967] 15 p refs

(Grant NsG-81)

(NASA-CR-89772) CFSTI: $3.00 CSCL 22A

Decision theory search strategies are discussed for Mars missions, emphasizing planetary quarantine considerations. In addition to the detection and characterization of life on Mars, attention is directed to the importance in mission decision analysis of judging the future utility of Mars and the possibilities of modifying Mars atmosphere, and of arriving at an explicit statement of the probabilities of back contamination of the Earth. A method of analysis used in a pilot problem of a simplified version of the decision required in selecting Voyager–Mars mission configurations is also examined. E.C.

N67-40533*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

DATA MANAGEMENT STUDY, VOLUME 5. APPENDIX B: CONTRACTOR DATA PACKAGE PLANETARY QUARANTINE (PQ) Final Report

W. E. Johnston and F. S. Nayor 28 Jul. 1967 56 p Prepared for JPL

(Contracts NAS7-100; JPL-951112)

(NASA-CR-89706; VOY-CO-FR, Vol. 5, Append. B) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The data item matrix, data requirement descriptions, user flow diagram, document relationship tree, and frequency and phasing charts for planetary quarantine are presented. These data relate to microbiological factors; sterilization, contamination, and decontamination considerations; related assaying, assembly, and testing operations; and all other information of direct relevance to the planning, control, review, and reporting of the Voyager planetary quarantine program. Author

N67-40537# Air Force Systems Command, Wright-Patterson AFB, Ohio. Aero Propulsion Lab.

AN ASSESSMENT OF THE PRACTICALITY OF ORBITAL MAINTENANCE

Peter N. Van Schaik Aug. 1967 21 p refs Presented at the AIAA Conf. on Space Programs Issues of the 70's, Seattle, 28–30 Aug. 1967

(AFAPL-CONF-68-3; AD-658454)

Spacecraft and space stations orbiting the earth for long periods of time will incur many malfunctions requiring redundancy or orbital maintenance. Redundancy will suffice for the shorter periods while maintenance becomes a necessity in the long run. For maintenance to become a reality it must be both system and cost effective. It will never become effective unless the spacecraft is maintainable, spares are interchangeable, and man can make in-space repairs. Current programs are slowly advancing the technologies but a concentrated, comprehensive program is needed to make maintenance a reality reasonably soon. Author (TAB)

N67-40551* Bellcomm, Inc., Washington, D. C.

A COMPUTER PROGRAM FOR SIMULATING UPRATED SATURN I TRAJECTORIES

V. J. Esposito 29 Sep. 1967 28 p refs

(Contract NASw-417)

(NASA-CR-89758; TM-67-1021-2) CSCL 22C

A computer program has been developed which extends the capability of the BCMASP simulator to cover Uprated Saturn I trajectories. The basic BCMASP format and structure is utilized throughout with the targeting and event sequencing subroutines modified as necessary. The trajectory model includes both manned and unmanned launch configurations, and has a provision for the incorporation of a wind velocity profile during the critical early stages of the trajectory if desired. Preliminary reference trajectories can be duplicated with differences on the order of 0.1% in final payload and other critical parameters. The more sophisticated operational trajectories can be duplicated to an accuracy of about .6%. Among the potential areas suitable for analysis with the Uprated Saturn I simulator are launch vehicle payload capability studies, engine failure and abort problems, and the initial phases of rendezvous missions. Author

N67-40588*# McDonnell Aircraft Corp., St. Louis, Mo.

VOYAGER CAPSULE PHASE B. VOLUME IV: ENTRY SCIENCE PACKAGE. PART E: ALTERNATIVES AND SYSTEMS ANALYSIS. PART F: FUTURE MISSION OPTIONS Final Report

31 Aug. 1967 267 p refs Prepared for JPL

(Contracts NAS7-100; JPL-952000)

(NASA-CR-89700; F694, Vol. IV, Pt. E and F) CFSTI: HC $3.00/MF $0.65 CSCL 22A

This is the second of four volumes which together contain a study of science objectives of the Entry Science Package (ESP), the design and operational mission alternatives, and a description of the preferred design, its functional operation, and the rationale for its selection. This volume specifically covers the alternatives that were considered, an analysis, and a brief indication of future mission options. Included are details on the following: (1) configuration and interface alternatives; (2) alternatives for atmospheric properties experiments; (3) science instrumentation, including atmospheric properties instruments and entry TV; (4) ESP

supporting subsystems, including electric power, telecommunications, structural/mechanical, packaging and cabling, and thermal control; (5) capsule bus/entry science, including trajectories, aeroshell properties, and touchdown operations; and (6) future mission options. K.S.

N67-40560*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME IV: ENTRY SCIENCE PACKAGE. PART H: RELIABILITY. PART I: PLANETARY QUARANTINE. PART J: OPERATIONAL SUPPORT EQUIPMENT. PART K: INTERFACE ALTERNATIVES Final Report
31 Aug. 1967 318 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89702; F694, Vol. IV, Pt. H, I, J, K) CFSTI: $3.00 CSCL 22B

This is the fourth of four volumes which together contain a study of science objectives of the Entry Science Package (ESP), the design and operational mission alternatives, and a description of the preferred design, its functional operation, and the rationale for its selection. Covered in the present volume are reliability, planetary quarantine, operational support equipment, interfaces and alternatives for ESP management, and technical interface responsibility. The coverage includes details on the following: (1) Voyager reliability constraints, failure modes, reliability estimates and requirements, and component reliability; (2) planetary quarantine constraints and requirements, contamination factors, and design and maintenance of sterility; (3) requirements and constraints of operational support equipment, system level support equipment, level test equipment for ESP subsystems, handling and servicing equipment, spacecraft-mounted ESP support equipment, and software; and (4) interface alternatives for systems and the selected ESP design. K.W.

N67-40564*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
SUMMER 1967 STUDY OF LUNAR SCIENCE AND EXPLORATION
Wilmot N. Hess Washington, NASA, 1967 405 p Summer Study held at the Univ. of Calif., Santa Cruz, Calif., 31 Jul.–15 Aug. 1967
(NASA-SP-157) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A conference to decide the future lunar manned and unmanned exploration program, particularly in the time frame of the Apollo Applications Program, is discussed. Efforts were aimed at drawing up a recommended list of lunar missions with detailed mission plans and priority experiment lists for each, deciding on a priority list of major hardware items, and making recommendations for instrument development and for supporting research and technology programs. The most important recommendations pertain to increasing astronaut operation ranges on the moon. Reports from working groups on geology, geophysics, geochemistry, bioscience, geodesy and cartography, lunar atmospheres, particles and fields, and astronomy are presented. Also included is a preliminary photogeologic map of the Alphonsus region of the moon. S.P.

N67-40575*# National Aeronautics and Space Administration, Washington, D. C.
THE COUNTDOWN
1967 4 p refs
(NASA Facts S-4/8-67) GPO: $0.05 CSCL 22A

A description of the countdown procedures suitable for elementary school general science is presented. The checkoff list is emphasized, and the automatic sequencer for manned flights is mentioned. The service structure and the world wide tracking network are also briefly described. N.E.N.

N67-40580* Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.
AEROSPACE SYSTEMS AND MISSION ANALYSIS RESEARCH Status Report, 1 Jul.–30 Sep. 1967
P. M. Lion 1 Oct. 1967 16 p refs
(Contract NASr-231)
(NASA-CR-89638) CSCL 22A

Continuing research is reported on spaceflight trajectories, aerospace systems, and interplanetary–planetary missions. Primary effort in the trajectory analysis was directed toward the completion of the Lion 1 program and of the multi-impulse program, which has been modified in the numerical procedures for obtaining solutions of Lambert's problem and the state-transition matrix. Nuclear rocket system analysis is described, emphasizing its mathematical model. A comparison, made with Gordon II, of the capabilities of Atlas (SLV3C)/Centaur, Titan IIIC(1207)/Centaur, and Saturn IB/Centaur is presented for a 600-day Jupiter flyby. The latter two are considered adequate. The feasibility of an on-board microwave radar is discussed for detection, range, and position-angle measurement of asteroids from a spacecraft. An asteroid distribution model is derived, and is combined with a scanning mode in which a fixed beam is transverse to flight path. N.E.N.

N67-40582*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME III: SURFACE LABORATORY SYSTEM. PART B1: ALTERNATIVES, ANALYSES, SELECTION Final Report
31 Aug. 1967 189 p refs Prepared for JPL (Contracts NAS7-100; JPL-952000)
(NASA-CR-89692; F694, Vol. III, Pt. B1) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Selection of the preferred capsule bus design was based on comparative studies of the performance of several candidate concepts. The objective of this selection was to determine a design which meets all of the constraints and which performs the capsule mission successfully. Emphasized was the optimization of the entire flight capsule, rather than any individual subsystem. Achievement of capsule landing, performance of entry science experiments, and performance of landed science experiments were treated as the primary mission objectives. Compatibility with growth toward future mission requirements was also emphasized in the selection process. Probability of mission success was the most important single optimization criterion. Other criteria considered were system performance, development risk, versatility, and cost. Mission analyses determined the range of profiles which satisfy mission objectives and are compatible with the capabilities of the flight capsule and other Voyager systems. Functional requirements on various subsystems were established from the mission profile. The alternatives considered for satisfying these requirements and the analyses leading to selection of a preferred concept are described. Major trade studies and systems analyses focused on the following: science integration; leveling requirements; surface laboratory alternatives; in-flight/landed monitoring and checkout; independent data package evaluations; system effectiveness analyses; and extended mission evaluations. S.C.W.

N67-40583*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME III: SURFACE LABORATORY SYSTEM. PART B2: ALTERNATIVES, ANALYSES, SELECTION Final Report
31 Aug. 1967 219 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89693, F694, Vol. III, Pt. B2) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A description of surface laboratory subsystems and the alternatives for each preferred design selection is presented. Included are data on the electrical power subsystem; the sequencing and timing subsystem; the control subsystem high gain antenna; and the telecommunications subsystem. S.C.W.

N67-40588*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME III: SURFACE LABORATORY SYSTEM. PART E: RELIABILITY Final Report
31 Aug. 1967 88 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89698; F694, Vol. III, Pt. E) CFSTI: $3.00 CSCL 22A

Engineering reliability studies were conducted to determine Voyager reliability constraints, failure mode effects and criticality, quantitative reliability estimates, reliability program requirements, and component part reliability. Each Voyager concept was evaluated in terms of its capability for first time success and for degraded mode operation. This was accomplished by using four analytical and modeling techniques: 1) failure mode, effect, and criticality analyses; 2) reliability-weight-effectiveness analyses; 3) mission effectiveness model; and 4) conceptual tradeoff studies. Analyses of critical or potential single point failure modes indicated the need for specific redundancies. The selection of specific redundancies was guided by the failure criticality of the mission event or equipment function, and by weight. The reliability-weight-effectiveness analyses resulted in the effective incorporation of 71 redundancies and an estimated probability of success of the preferred surface laboratory concept of 0.776. Equipment sensitivity to long-term storage was considered, and alternate design concepts were evaluated to determine their compatibility with decontamination, sterilization, and Martian environments. R.N.A.

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

N67-39455# Aerospace Corp., El Segundo, Calif. Technical Operations.
ACTIVE DAMPING CONCEPT FOR GRAVITY GRADIENT SATELLITE ATTITUDE CONTROL
Alfred S. Gutman Jul. 1967 16 p refs
(Contract AF 04(695)-1001)
(TR-1001(2525-05)-2; SAMSO-TR-67-1; AD-657764)

The report describes a concept for a satellite gravity gradient stabilization system. It utilizes active damping to reduce the oscillation time constant and the initial capture time and also to reduce the oscillation magnitude (amplitude). The active damper described is conceptually capable of achieving high reliability. It consists of an elastically suspended control rod driven by an electromagnetic actuator; the actuator is excited by a servo amplifier which is controlled by an optical sensor. This attitude control concept may be implemented to provide automatic correction of errors caused by bias torques. Author (TAB)

N67-39951*# Wyle Labs., Inc., Huntsville, Ala. Testing Div.
AIR SHOCK PARAMETERS AND DESIGN CRITERIA FOR ROCKET EXPLOSIONS
F. V. Bracco Sep. 1965 96 p refs
(Contract NAS8-11217)
(NASA-CR-89622; WR-65-21) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Specific design charts and recommendations are presented for the calculations of rocket explosion air blast parameters of interest in structural load calculations. Parameters, based on far-field-TNT-equivalencies are defined for the far-, medium-, and close-field of rocket explosions. For the far- and medium-field, the far-field-TNT-equivalencies are believed to give sufficient accuracy while for the close-field they are believed to give conservative results. In the present report, examples are given for the far- and medium-field blast parameters. The blast parameters charts for the medium-field can also be used for the close-field if desired; however, it is the author's intent to present more realistic values for the close-field air blast parameters in a later report. In the appendices more detailed consideration is given to several pertinent aspects of the rocket explosion problem. Statistical analysis of propellant explosion data (to determine TNT equivalencies for large rockets), initial air shock velocities, rate of energy release, and far-field focusing effects are recognized as critical areas for which further studies are suggested. Author

N67-40011*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ATLAS-CENTAUR-SURVEYOR LONGITUDINAL DYNAMICS TEST
Theodore F. Gerus, John A. Housely, and George Kusic Washington, NASA, Oct. 1967 29 p refs
(NASA-TM-X-1459) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Full-scale dynamics tests were conducted to investigate engine-structure coupled longitudinal oscillations (POGO) of the Atlas–Centaur launch vehicle. Dynamic characteristics determined are natural frequencies, damping ratios, mode shapes, and propellant pressure–force responses. Experimental values of first mode natural frequencies were in good agreement with analytical values. Second mode values were in close agreement for early flight times (near-full tanking condition) but theoretical values were much higher for near-empty tanking conditions. Mode shapes showed reasonably good agreement with the analytical model for this kind of experiment. The greatest discrepancy was found in the modal amplitudes of the propellant masses and propellant pressure–force responses. Structural damping values obtained showed that theoretical minimum requirements for stability of the engine-pump-structure loop are met in all cases, although marginal just before booster engine cutoff. Flight data have confirmed this marginal stability. Author

N67-40041*# McDonnel Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME I: SUMMARY Final Report
31 Aug. 1967 201 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89672; F694, Vol. I) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The preferred systems for the capsule bus system of the Voyager flight capsule are summarized. Mission objectives, design criteria, and design constraints are presented; and the preferred capsule design is treated in terms of the mission analysis, capsule bus system, entry science package, and surface laboratory system. Capsule growth objectives, capsule bus standardization, and surface laboratory growth are summarized; and major planetary quarentine requirements and sterilization compatibility testing are reported. Redundancy use and potential reliability improvement for the capsule bus system are discussed; as are operational support equipment, interfaces, and implementation of the results. M.W.R.

N67-40042*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME II: CAPSULE BUS SYSTEM. PART A1: PREFERRED DESIGN CONCEPT Final Report
31 Aug. 1967 437 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89673; F694, Vol. II, Pt. A1) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Design criteria, requirements, and constraints for the capsule bus system of the Voyager spacecraft are presented; and overall mission objectives and the system configuration and its major subsystems are detailed. The latter includes structural modes, electronic equipment, aerodynamic decelerator subsystem, pyrotechnic subsystem, thermal control, propulsion subsystem, and packaging and cabling. Weight data are summarized for the capsule bus, and uncertainty data are included. Mention is made of weight qualification data, spacecraft-mounted equipment, and capsule bus items left on the aft canister/adapter after separation. Voyager reliability constraints are noted, as are failure mode effect and criticality analyses, system reliability estimate results, and reliability program requirements. M.W.R.

N67-40043*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME II: CAPSULE BUS SYSTEM. PART A2: PREFERRED DESIGN CONCEPT Final Report
31 Aug. 1967 179 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89674; F694, Vol. II, Pt. A2) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Planetary quarantine, operational support equipment, system interfaces and implementation, and applications to future space missions are reviewed in terms of the preferred design concept for the capsule bus system of the Voyager flight capsule. Contamination factors, design and maintenance of sterility, and the sterilization plan are presented; and support equipment is discussed in terms of the system test complex, launch complex equipment, mission dependent equipment, subsystem level test equipment, handling and servicing, and software. Environmental design parameters and structural design criteria are considered. Design mass properties, basic criteria, and mission phases are noted for the structural design criteria. M.W.R.

N67-40044*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME II: CAPSULE BUS SYSTEM. PART B1: ALTERNATIVES, ANALYSES, SELECTION Final Report
31 Aug. 1967 295 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89675; F694, Vol. II, Pt. B1) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Analysis and selection of the optimum capsule bus design for the Voyager flight capsule are reported, including feasibility testing and the selection criteria. A detailed mission analysis considers phase, constraints, various analyses made, and final profile selection. These analyses included orbital determination, capsule bus-flight spacecraft separation, de-orbit, atmospheric flight mechanics, deployable aerodynamic decelerator, terminal decelerator, landing site selection, and effects of capsule bus mission selection on spacecraft life. Types of mission profiles are noted, along with the mission profile formulation, profile evaluation and selection, and actual mission selection. System functional requirements imposed on the capsule bus system by the Voyager mission objectives are noted. M.W.R.

N67-40045*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME II: CAPSULE BUS SYSTEM. PART B2: ALTERNATIVES, ANALYSES, SELECTION Final Report
31 Aug. 1967 243 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89676; F694, Vol. II, Pt. B2) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Configuration selection for the aeroshell, lander, and terminal decelerator and propulsion are detailed for the capsule bus system of the Voyager spacecraft in a report of the major tradeoffs and systems analyses. Aeroshell candidates are noted and evaluated in terms of mission objectives and optimum sphere-cone selection is discussed. Attention is given to a deployable aerodynamic decelerator; and functional and technical requirements as well as design approaches and characteristics are reported for the terminal propulsion system, the terminal decelerator, aeroshell/lander separation, orbital descent attitude, and the independent data package. In-flight monitoring and checkout are discussed, as is the system effectiveness analysis. M.W.R.

N67-40046*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME II: CAPSULE BUS SYSTEM. PART B3: ALTERNATIVES, ANALYSES, SELECTION Final Report
31 Aug. 1967 389 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89677; F964, Vol. II, Pt. B3) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Sterilization canister, adapter, aeroshell, and lander subsystem analyses are detailed for the capsule bus system of the Voyager spacecraft. Details are included for the canister configuration selection and its structure and electrical optimization. Separation, pressure, and venting studies are included for the canister. Design constraints and requirements, along with the alternative design approaches and the structural analysis of the preferred truss adapter are reported. Structure and heat shield details are included for the aeroshell; and general stability studies of legged concepts and the preferred concept for the lander are reported. M.W.R.

N67-40047*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME II: CAPSULE BUS SYSTEM. PART B4: ALTERNATIVES, ANALYSES, SELECTION Final Report
31 Aug. 1967 258 p refs Prepared for JPL (Contracts NAS7-100; JPL-952000)
(NASA-CR-89678; F694, Vol. II, Pt. B4) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Telecommunications, the power and guidance and control subsystems, sequencing and timing, and radar are detailed in terms of the selection of optimum alternatives for the capsule bus system of the Voyager spacecraft. Following a summary of the capsule link propagation analysis based on a 340–400 MHz relay link to the spacecraft, the telemetry, radio, antenna, and data storage subsystems are described. The interconnection with the entry science package is noted, and the use of data compression is reviewed. Radar requirements resulting from selection of the preferred landing concept are reported, along with landing radar selection and performance. Altimeter requirements, alternatives, and selection and performance of the preferred altimeter design are discussed. M.W.R.

N67-40048*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME II: CAPSULE BUS SYSTEM. PART C1: FUNCTIONAL DESCRIPTIONS Final Report

31 Aug. 1967 275 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89679; F694, Vol. II, Pt. C1) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Detailed subsystem functional descriptions are reported for the structural/mechanical, telemetry, radio, antenna, data storage, and command subsystems of the preferred capsule bus system for the Voyager spacecraft. Details are included for equipment incorporated into the subsystems, and reliability analyses are presented via functional block diagrams. Sterilization canister, adapter, aeroshell, and lander characteristics and performance are considered under the structural/mechanical subsystem. The telemetry subsystem deals with various aspects of the capsule bus telemetry equipment, spacecraft-mounted flight capsule telemetry equipment, and telemetry instrumentation. The capsule bus radio and spacecraft-mounted capsule bus support radio are described, along with the capsule bus transmitting antenna and its reliability and safety constraints. M.W.R.

N67-40049*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME II: CAPSULE BUS SYSTEM. PART C2: FUNCTIONAL DESCRIPTIONS Final Report
31 Aug. 1967 235 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89688; F694, Vol. II, Pt. C2) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Equipment identification, usage, and other functional aspects of 10 subsystems of the capsule bus system of the Voyager spacecraft are described. Interface, test requirements, and reliability and safety are discussed for most of the subsystems. Attention is given to the test programmer of the sequencer subsystem, the radar altimeter and landing radar of the guidance sensor subsystem, and design and operational aspects of packaging and cabling. The other subsystems considered are electrical power, guidance and control, aerodynamic decelerator, pyrotechnic, thermal control, de-orbit propulsion, reaction control, and terminal propulsion of the capsule bus. M.W.R.

N67-40050*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME II: CAPSULE BUS SYSTEM. PART D: OPERATIONAL SUPPORT EQUIPMENT Final Report
31 Aug. 1967 266 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89689; F694, Vol. II, Pt. D) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Based on a systems-oriented analysis of Voyager program requirements and capsule operational support equipment (OSE) guidelines and constraints, an OSE concept was developed for the preferred capsule bus system of the Voyager spacecraft. This preferred approach is discussed, and both system-level support equipment and subsystem-level test equipment are discussed in detail; including the test sets for the electrical power, sequencer, guidance and control, radar, thermal control, and pyrotechnic subsystems. Attention is given to the assembly, handling, shipping, and servicing equipment; spacecraft-mounted capsule bus support equipment; and software management, packaging, development, and control/documentation. Supporting analysis and trade studies are included. M.W.R.

N67-40051*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME II: CAPSULE BUS SYSTEM. PART E: RELIABILITY Final Report
31 Aug. 1966 102 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89690; F694, Vol. II, Pt. E) CFSTI: $3.00 CSCL 22B

Engineering reliability studies related to Voyager system design are summarized in terms of satisfying the constraints imposed by the capsule bus system, failure mode effects and criticality analysis, quantitative reliability estimates, reliability program requirements, and component part reliability. Analytical and modeling techniques used to examine the various design concepts were (1) failure modes, effect, and criticality analyses; (2) reliability-weight-effectiveness analyses; (3) mission effectiveness model; and (4) conceptual tradeoff studies. The single-point failure modes, failure effect, and failure criticality analyses indicated specific redundancies so that no single failure mode could have a catastrophic effect on the mission. Selection of functional, multichannel, or block redundancy was guided by the failure criticality of the mission event or equipment; and the reliability-weight-effectiveness analyses resulted in the use of redundancy to best meet the mission objectives. Probability of success for the Voyager capsule bus preferred concept is estimated at 0.830. General specifications for Voyager flight capsule semiconductors, transistors, diodes, and integrated circuits are included. M.W.R.

N67-40183*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DELTA VEHICLE FLIGHT FAILURE REPORT LAUNCH 33
Oct. 1966 80 p
(NASA-TM-X-55988; X-470-66-509) CFSTI: HC $3.00 CSCL 22D

The Delta three-stage vehicle that launched the OSO-C spacecraft from complex 17, Pad B, at Cape Kennedy, Florida on August 25, 1965, experienced a flight failure. A review of vehicle T/M data indicated nominal performance of the first and second stages up to 0.61 seconds after spin-up of the third stage. At this time the third stage chamber pressure rose indicating premature ignition of the third stage motor. Simultaneously, severe second stage attitude disturbances were experienced accompanied by second stage T/M dropout. Separation of the third stage from the second stage was probably affected by burning through the spin table. Investigation of the possible causes for the premature ignition established that malfunction of the six second time delay squib used to ignite the third stage motor was the most probable cause of the failure. Tests conducted on this type of squib during the failure investigation revealed that the most probable mode of failure was blow-by of the hot gases from the ignition charge passed the six (6) second time delay train and igniting the main output charge of the squib. Author

N67-40224*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
WIND-TUNNEL INVESTIGATION OF SATURN S-IC AERODYNAMIC ENGINE GIMBAL FORCES AND BASE PRESSURES USING A COLD-FLOW-JET SIMULATION TECHNIQUE
Bernard J. Bisha, Robert A. Wasko, and Donald L. Bresnahan Washington, NASA, Nov. 1967 51 p refs
(NASA-TM-X-1470) CFSTI: HC $3.00/MF $0.65 CSCL 22D

An investigation was made of the aerodynamic hinge moments of two of the F-1 engine nozzles on a 0.01585 scale model of the S-IC boost stage of the Saturn V launch vehicle utilizing a cold-flow-jet simulation technique. High-pressure dried air at room temperature was used for nozzle flow. The investigation was made over a Mach number range of 0.56 to 3.5 for 0°, 5°, and 10° angles of attack; 0°, 1.5°, and 3° gimbal angles; 0° and 45° roll

angles; and for three sizes of base flow deflectors. Model base pressures were also investigated. Jet-on and jet-off comparisons were made to determine jet effects on both nozzle hinge moment and base pressures. Nozzle-hinge-moment coefficients were increased by the presence of base flow deflectors. Jet flow generally increased the magnitude of hinge moments over those at the jet-off condition. Base pressure was increased by the presence of base flow deflectors at all Mach numbers. At lower Mach numbers, base pressures were constant across the base and less than free-stream static pressure. At high Mach numbers, base pressures were greater than free-stream static pressure and decreased from the inner to the outer regions of the base. Jet-on base pressures were less than pressures at jet-off conditions below Mach 1.0 but greater at higher speeds. Author

N67-40234*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME II CAPSULE BUS SYSTEM. PART B5: ALTERNATIVES, ANALYSES, SELECTION Final Report
31 Aug. 1967 333 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89686; F694, Vol. II, Pt. B5) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The aerodynamic decelerator subsystem, pyrotechnics, thermal control, and propulsion are detailed for the Voyager capsule bus system; and packaging and cabling as well as the independent data package are described. Constraints, an analysis of subsystem sizing and sequence, and operational environment and performance are detailed for the decelerator subsystem. Standardization problem areas, alternatives, and recommended design approach are included for the pyrotechnics; and thermal control of the capsule bus is considered for missions using battery power. De-orbit propulsion, attitude control, terminal propulsion, and supporting design studies are discussed. Independent data package operation, electronic subject, and mechanical subject studies are reported, along with mission considerations and constraints and environment measurement studies. M.W.R.

N67-40331*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PRELIMINARY LAUNCH VEHICLE FLIGHT EVALUATION REPORT NASA APPLICATIONS TECHNOLOGICAL SATELLITE (ATS) PROGRAM FLIGHT NO. 1, NASA ATLAS–AGENA NO. 19 (LAUNCHED DECEMBER 6, 1966)
Washington, NASA, 1967 85 p refs
(NASA-TM-X-52348) CFSTI: HC $3.00 CSCL 22B

The NASA Applications Technological Satellite—1 (ATS-1) Atlas/Agena Vehicle, carrying 1550 lb of separable payload, was successfully launched. The vehicle flight consisted of an Atlas boost, an Agena first burn, an intervening Agena–spacecraft coast, and an Agena second burn. All aerospace ground equipment operated satisfactorily during countdown and launch, except that the 2-inch motion switch malfunctioned at lift-off. All Atlas systems performed satisfactorily. All Agena systems performed satisfactorily with the exception of a momentary drop in engine chamber pressure during second burn. This momentary drop had no adverse effect on the flight results. The ATS-1 flight was the first to use as a spacecraft aerodynamic shroud the Standard Agena Clamshell shroud. The shroud performed successfully during the flight. The ATA-1 launch vehicle flight performance, each major Atlas and Agena vehicle borne system, the ground radio guidance system, and the spacecraft shroud system are described. The performance of each system is evaluated, and significant data are presented. Author

N67-40387# National Research Council of Canada, Ottawa (Ontario). Space Research Facilities Branch.
BLACK BRANT ROCKET AAF-VA-107 LAUNCHED AT CHURCHILL RESEARCH RANGE, 13 DECEMBER 1966
Aug. 1967 36 p refs
(SRFB-006) CFSTI: HC $3.00/MF $0.65

The engineering aspects of preparing the payload and the launching of Black Brant rocket AAF-VA-107 at Churchill Research Range on 13 December 1966 are discussed. The primary experiment was the measurement of micrometeoroid population during the peak period of the Geminid meteor shower. Other experiments included measurements of geophysical conditions during the flight. Test objectives were not met because the vehicle suffered a malfunction and failed to achieve sufficient altitude to satisfy experiment requirements. Author

N67-40393# Aerospace Corp., El Segundo, Calif.
EFFECT OF POINT ARGUELLO WIND VARIABILITY UPON RANGE SAFETY CONSIDERATIONS AT WTR, DECEMBER 1965–JULY 1966
Richard G. Stern Aug. 1967 33 p
(Contract FO4695-67-C-0158)
(TR-0158(3301)-1; SAMSO-TR-67-8; AD-658847)

The effect of wind variability at Western Test Range (WTR) upon a launch vehicles instantaneous impact point (IIP) is determined in this report. It is shown that winds may cause the instantaneous impact points of a properly functioning booster to cross over the destruct line and hence be destroyed. An evaluation of preflight wind conditions is necessary when the launch azimuths are such that the nominal trajectory lies in close proximity to the destruct line. To estimate the wind induced variations in IIP or debris impact points occurring between the times a preflight wind sounding is made and launch occurs, 6-hr wind variability statistics were compiled for Point Arguello. A linear technique for determining the variability in IIP or debris impact points from the statistics was utilized for a typical launch vehicle. The wind induced standard deviation in IIP or debris impact points over a 6-hr period was found to be from one-third to one-half of the standard deviation for the monthly variation. The standard deviations of component 6-hr wind differences at a given altitude were found generally to be about one-half that of the monthly component wind standard deviations. Author (TAB)

N67-40442*# Martin Co., Denver, Colo.
VOYAGER CAPSULE, PRELIMINARY DESIGN, PHASE B. VOLUME I: SUMMARY Final Report
31 Aug. 1967 65 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952001)
(NASA-CR-89730; FR-22-103, Vol. I) CFSTI: HC $3.00 CSCL 22B

Technical highlights of the integrated test, and implementation plans for the design of the Voyager capsule, are presented. A preferred configuration was selected that integrates automated spacecraft technology experience and emphasizes simplicity to ensure reasonable cost and availability for the 1973 launch opportunity. Modularity and standardization were developed. Other configurations, including a ring lander and an RTG-powered alternative, are also discussed. L.S.

N67-40443*# Martin Co., Denver, Colo.
VOYAGER CAPSULE, PRELIMINARY DESIGN, PHASE B. VOLUME II: CAPSULE BUS SYSTEM. SECTION I: CAPSULE BUS Final Report

31 Aug. 1967 709 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952001)
(NASA-CR-89722; FR-22-103, Vol. II, Sect. I) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The results of the preliminary design studies for the Voyager Capsule Bus System are presented. Requirements and constraints, structures, subsystems, orbit selection, support equipment, and environmental requirements are discussed. Subsystems described include the telemetry, communications, propulsion, thermal control, power, pyrotechnic, cabling, guidance and control, and command and sequencing subsystems. Electronics packaging and installation are also discussed. L.S.

N67-40444*# Martin Co., Denver, Colo.
VOYAGER CAPSULE, PRELIMINARY DESIGN, PHASE B. VOLUME II: CAPSULE BUS SYSTEM. SECTION II: PRELIMINARY DESIGN FOR OSE Final Report
31 Aug. 1967 214 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952001)
(NASA-CR-89723; FR-22-103, Vol. II, Sect. II) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The requirements, constraints, and conceptual implementation of the Operational Support Equipment (OSE) and Mission-Dependent Equipment (MDE) for the Capsule Bus portion of the Voyager Flight Capsule, are described. The OSE (S/S) Subsystem; System Test Complex (STC) Equipment; Launch Complex Equipment (LCE); and Assembly, Handling, and Shipping Equipment (AHSE) are described in detail. L.S.

N67-40445*# Martin Co., Denver, Colo.
VOYAGER CAPSULE, PRELIMINARY DESIGN, PHASE B. VOLUME III: SURFACE LABORATORY SYSTEM. SECTION I: SURFACE LABORATORY Final Report
31 Aug. 1967 567 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952001)
(NASA-CR-89724; FR-22-103, Vol. III, Sect. I) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The requirements and constraints used in selecting the preferred Surface Laboratory configuration selected for the Voyager mission; a summary of the studies and analyses affecting the system configuration; and the rationale for the preferred configuration, are presented. Subsystems discussed include the thermal control; communications; telemetry; cabling; command and sequencing; power; pyrotechnic; landed science; structures and mechanics; and packaging subsystems. Spacecraft-mounted flight capsule support equipment are also described; and environmental conditions to which the Voyager equipment will be exposed, are studied. L.S.

N67-40446*# Martin Co., Denver, Colo.
VOYAGER CAPSULE, PRELIMINARY DESIGN, PHASE B. VOLUME III: SURFACE LABORATORY SYSTEM. SECTION II: PRELIMINARY DESIGN FOR OSE Final Report
31 Aug. 1967 218 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952001)
(NASA-CR-89725; FR-22-103, Vol. III, Sect. II) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The requirements, constraints, and conceptual implementation of the Operational Support Equipment (OSE) and Mission-Dependent Equipment (MDE) for the Surface Laboratory (S/L) portion of the Voyager Capsule Bus System, are described. The subsystem OSE: Systems Test Complex; Launch Complex Equipment; and Assembly, Handling, and Shipping Equipment (AHSE) characteristics, trade studies, and functions are described in detail. L.S.

N67-40447*# Martin Co., Denver, Colo.
VOYAGER CAPSULE, PRELIMINARY DESIGN, PHASE B. VOLUME IV: ENTRY SCIENCE PACKAGE. SECTION I: ENTRY SCIENCE PACKAGE Final Report
31 Aug. 1967 215 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952001)
(NASA-CR-89726; FR-22-103, Vol. IV, Sect. I) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Functional and performance requirements and constraints on the preliminary design of the Entry Science Package (ESP) portion of the Voyager Flight Capsule are described. The ESP is designed to make atmospheric and surface imaging measurements and transmit the data as independently as practical. These functions must satisfy the operating period accuracy requirements which must be satisfied within the design, reliability, sterilization, contamination, weight, and development constraints. The configurations of the ESP subsystems; structures and mechanisms, thermal control, entry science, communications, power, pyrotechnic, and cabling, are described and discussed. L.S.

N67-40448*# Martin Co., Denver, Colo.
VOYAGER CAPSULE, PRELIMINARY DESIGN, PHASE B. VOLUME IV: ENTRY SCIENCE PACKAGE. SECTION II: PRELIMINARY DESIGN FOR OSE Final Report
31 Aug. 1967 131 p refs Parepared for JPL
(Contracts NAS7-100; JPL-952001)
(NASA-CR-89727; FR-22-103, Vol. IV, Sect. II) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The general requirements and conceptual implementation of the Operational Support Equipment (OSE) and Mission-Dependent Equipment (MDE) for the Entry Science Package (ESP) portion of the Voyager Flight Capsule System, are described. The OSE subsystem; System Test Complex (STC); Launch Complex Equipment (LCE); and Assembly, Handling, and Shipping Equipment (AHSE) for the OSE are described in detail. In addition, the flight subsystem configuration and integrated test requirements, and supporting analyses and trade studies are described. L.S.

N67-40449*# Martin Co., Denver, Colo.
VOYAGER CAPSULE, PRELIMINARY DESIGN, PHASE B. VOLUME IV: ENTRY SCIENCE PACKAGE. SECTION V: INTERFACES Final Report
31 Aug. 1967 23 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952001)
(NASA-CR-89728; FR-22-103, Vol. IV, Sect. V) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Specific hardware, software, and service interfaces between the Capsule Bus and the Entry Science Package, and between the combination of these (as a flight capsule) and the Voyager Spacecraft are described. The Voyagar Capsule systems interfaces are identified and preliminarily defined. The effects of physical, functional, environmental, test, and operational requirements (plus the managerial relationships to be established) on the interfaces, are considered. Methods for accomplishing contractor–customer coordination, negotiation, and control of interfaces, are proposed. L.S.

N67-40450*# Martin Co., Denver, Colo.
VOYAGER CAPSULE, PRELIMINARY DESIGN, PHASE B. VOLUME V: INTERFACE DESCRIPTIONS Final Report
31 Aug. 1967 55 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952001)
(NASA-CR-89729; FR-22-103, Vol. V) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Specific hardware, software, and service interfaces between the Capsule Bus, the Entry Science Package, the Surface Laboratory,

and between the combination of these and the Voyager Spacecraft, are described with respect to the physical, functional, and environmental test condition effects on the interfaces (and with respect to operational requirements and managerial relationships). The Voyager capsule systems are identified and preliminarily defined; and methods of implementing contractor–customer coordination, negotiation, and control of interfaces, are proposed. L.S.

N67-40493*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DEVELOPMENT OF THE INTERPLANETARY PIONEER SPACECRAFT
Charles F. Hall and Aubrey B. Mickelwait (TRW Systems) [1967] 13 p Presented at the Systems Eng. I (Unmanned) Session at the 18th IAF Congr., Belgrade, Sep. 1967
(NASA-TM-X-60564) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The systems engineering aspects of developing the Interplanetary Pioneer Spacecraft are discussed in relation to the tools, techniques, and procedures available for correlating the diverse elements within the program so that the objectives are met within the technical, fiscal, and schedule constraints. The organization chart shows six units within the project office with specific responsibility for the seven external subsystem elements, and four units with responsibility for one function. Details are given on the design and development phase, which covered the preparation of basic specifications, interface specifications for major elements, design reviews, and the impact of subsystem design or design changes on the overall system. Fabrication monitoring is discussed. Participation in environmental, functional, and performance test programs is described, and flight experience on Pioneer VI and VII is reviewed. M.G.J.

N67-40800* National Aeronautics and Space Administration, Washington, D. C.
SURVEYOR
1967 12 p
(NASA Facts, Vol. IV, No. 6) GPO: $0.15 CSCL 22B

The accomplishments of the Surveyor I spacecraft are briefly discussed followed by details of the spacecraft's launching, flight, and lunar landing. General features of the spacecraft, its electronic equipment, and telecommunications equipment are described. A detailed account of Surveyor's lunar operations, including its survival of the lunar night and later difficulties with its power system, is given. Also included are a summary of some of the new information obtained by Surveyor on lunar conditions and an outline of the Surveyor program objectives. R.N.A.

N67-40557*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME IV: ENTRY SCIENCE PACKAGE. PART A: INTRODUCTION AND SUMMARY. PART B: MISSION OBJECTIVES AND REQUIREMENTS. PART C: CONSTRAINTS. PART D: SELECTED DESIGN CONCEPTS Final Report
31 Aug. 1967 287 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89699; F694, Vol. IV, Pt. A, B, C, D) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The science objectives of the Entry Science Package (ESP) are determination of Mars atmospheric properties and visual imaging. This volume is the first of four which together contain a study of science objectives, the design and operational mission alternatives, and a description of the preferred design, its functional operation, and the rationale for its selection. Specifically, the present volume covers objectives and requirements, constraints, and the selected concept. Described in detail are: (1) mission objectives, profile, and ESP requirements; (2) general and interface constraints, electromagnetic compatibility, and environmental, structural, equipment, and subsystem constraints; and (3) selected configuration and entry experiments, supporting ESP subsystems, capsule bus/entry science interface, and implementation. K.W.

N67-40559*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME IV: ENTRY SCIENCE PACKAGE. PART G: SUBSYSTEM/EQUIPMENT DESCRIPTIONS Final Report
31 Aug. 1967 190 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89701; F694, Vol. IV, Pt. G) CFSTI: HC $3.00/MF $0.65 CSCL 22B

This is the third of four volumes which together contain a study of science objectives of the Entry Science Package (ESP), the design and operational mission alternatives, and a description of the preferred design, its functional operation, and the rationale for its selection. Given in this volume are comprehensive functional descriptions of major equipment and subsystems for the selected design concept. Specifically covered are the following: (1) description, performance, and reliability data of experiment and instrumentation; (2) data storage and telemetry subsystems; (3) ESP radio and antenna subsystems; (4) electrical power subsystem; (5) structural/mechanical subsystem; (6) packaging and cabling; and (7) the thermal control subsystem. K.W.

N67-40577*# Boeing Co., Seattle, Wash.
LUNAR ORBITER II. PHOTOGRAPHY
Washington, NASA, Nov. 1967 105 p
(Contract NAS1-3800)
(NASA-CR-931; D2-100752-2) CFSTI: $3.00 CSCL 22B

Mission photographic planning and conduct are described, and the resultant photographs are analyzed for the Lunar Orbiter Mission II designed to locate landing sites for the Apollo spacecraft. Exposure, processor-dryer, readout, and reassembly characteristics are described; and photographs and details of the primary and secondary landing sites are included along with input data, accuracy of calculations, and photograph frame coordinates, and photographic supporting data tables. Spacecraft operation and control as well as reconstruction operations are discussed. The photographic portion of the mission is considered to be very nearly a complete success. All of the schedules sites were photographed, and 98.5% of the photography was reconstructed before readout was terminated and the traveling wave tube amplifier failed to turn on. M.W.R.

N67-40581*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME III: SURFACE LABORATORY SYSTEM. PART A: PREFERRED DESIGN CONCEPT Final Report
31 Aug. 1967 302 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89691; F694, Vol. III, Pt. A) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Reported is an overall description of design concepts for a surface laboratory system which will be used on the first scheduled Voyager/Mars mission planned for 1973. Objectives of the surface laboratory system are to: obtain data on the Martian atmosphere and surface environment after landing, and make initial measurements relevant to the question of the presence of life; (2) develop a surface laboratory design employing communications and sequencing equipment that will be compatible with future Voyager missions; and (3) demonstrate surface operations for a period of at least one diurnal cycle plus the time required to complete

transmission of all acquired data. Requirements and constraints having a major influence on the design of the surface laboratory system are identified. The preferred concept for the 1973 surface laboratory is illustrated in position on the capsule bus, and the relationship of the surface laboratory to other Voyager flight systems is shown. Included are data on weight requirements, planetary quarantine, systems reliability, operational support equipment, system interfaces, implementation, utilization for future missions, environmental predictions, and future mission studies. S.C.W.

N67-40585*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME III: SURFACE LABORATORY SYSTEM. PART C1: SUBSYSTEM FUNCTIONAL DESCRIPTION Final Report
31 Aug. 1967 225 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89695; F694, Vol. III, Pt. C1) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Functional descriptions of subsystems and functional assemblies are presented which were selected to implement the surface laboratory design concept. These include the electrical power subsystem, sequencer subsystem, control subsystem, radio subsystem, antenna subsystem, command subsystem, telemetry subsystem, surface laboratory data storage subsystem, surface laboratory structure subsystem, and high gain antenna mechanism. Each description was developed from comprehensive engineering analyses and studies performed prior to, and during, Phase B of the Voyager Capsule Program. Each subsystem is described in terms of equipment identification and usage, design requirements and constraints, physical characteristics, operation, performance objectives, interface definition, reliability and safety considerations, and test and development requirements. R.N.A.

N67-40586*# McDonnell Aircraft Corp., St. Louis, Mo.
VOYAGER CAPSULE PHASE B. VOLUME III: SURFACE LABORATORY SYSTEM. PART C2: SUBSYSTEM FUNCTIONAL DESCRIPTION Final Report
31 Aug. 1967 191 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952000)
(NASA-CR-89696; F694, Vol. III, Pt. C2) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Functional descriptions are given of the pyrotechnic subsystem, packaging and cabling, thermal control subsystem, and science subsystem selected to implement the surface laboratory design concept. These subsystem descriptions were developed from extensive engineering analyses and investigations conducted before, and during, Phase B of the Voyager program. The subsystem functional descriptions cover equipment identification and usage, design requirements and constraints, physical characteristics, operation, performance objectives, interface definition, reliability and safety considerations, and test and development requirements. R.N.A.

N67-40589* National Aeronautics and Space Administration, Washington, D. C.
APOLLO 4
2 Nov. 1967 84 p
(NASA News Release-67-275) CSCL 22D

Launch of the Apollo/Saturn V space vehicle and its earth orbital unmanned mission are discussed. Objectives are to obtain flight information on launch vehicle and spacecraft structural integrity and compatibility, flight loads, stage separation, subsystem operation, emergency detection subsystem operation; and to evaluate the Apollo command module heat shield under conditions encountered on return from a moon mission. Such factors as the launch complex, assembly building, launch control center, mobile launcher, transporter, mobile service structure, water deluge system, flame trench and deflector, and pad areas are briefly considered. The manned space flight network is discussed with respect to such areas as ground systems for space guidance, command, and control, participating stations, testing, computers, satellite communications, reentry communications blackout, and high speed reentry. S.P.

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

N67-39382# State Univ. of New York at Buffalo. Interdisciplinary Studies and Research Div.
CREEP OF CONICAL MEMBRANE SHELLS UNDER AERODYNAMIC HEATING AND LOADING
F. A. Cozzarelli and R. P. Vito Jul. 1967 41 p refs
(Contract Nonr-4449(00))
(Rept.-18; AD-657843)

Expressions for the creep stresses and displacements in a conical shell at a small angle of attack to a supersonic flow field are obtained. The flow is assumed to be steady adiabatic and the cone is approximated by a membrane shell. Surface shear stresses are found to have a negligible effect on the solutions. On the other hand, temperature distributions which differ slightly from a given uniform valve result in displacements which differ significantly from those obtained using the uniform temperature. Author (TAB)

N67-39383# State Univ. of New York at Buffalo. Interdisciplinary Studies and Research.
SCATTERING OF ELASTIC WAVES BY RIGID OBSTACLES OF ARBITRARY SHAPE
Richard P. Shaw May 1967 14 p refs
(Contract Nonr-4449(00))
(Rept.-24; AD-657845)

The scattering of elastic waves by rigid obstacles of arbitrary shape is discussed in terms of an integro-differential equation similar to Kirchoffs equation. This approach has proved valuable in the treatment of acoustic scattering problems and the extension proposed is relatively straightforward. The advantage of this approach is that the problem can be formulated completely in terms of surface values of stress and strain thereby reducing the order of magnitude of the problem. From a numerical point of view this is a significant economy. Field values can be obtained from the surface values by a direct quadrature if required. A simple problem is discussed as an example of the procedure. More complicated problems are being considered as well as extensions of this approach to other boundary conditions (e.g. free, discontinuity in elastic properties, etc.). Author (TAB)

N67-39491*# Boeing Scientific Research Labs., Seattle Wash. Mathematics Research Lab.
THE PRECESSION AND NUTATION OF DEFORMABLE BODIES IV: DEFORMATION OF SELF-GRAVITATING ELASTIC SOLIDS

Zdenek Kopal Aug. 1967 58 p refs *Its* Mathematical Note No. 524
(Contract NASw-1470)
(NASA-CR-89520; D1-82-0636; AD-658212) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The report derives the explicit form of equivalent equations which govern the deformations of self-gravitating elastic bodies of non-uniform internal temperature, whose dynamical behavior is characterized by variable Lame parameters lambda and mu. Special respect will be paid to small deformations (or oscillations) about the state of hydrostatic equilibrium, characterized by spheroidal or toroidal symmetry. TAB

N67-39508*# Lockheed Missiles and Space Co., Palo Alto, Calif. Aerospace Sciences Lab.
PERFORMANCE OF MULTILAYER INSULATION SYSTEMS FOR TEMPERATURES TO 700°K Final Report, Oct. 1964–May 1967
George R. Cunnington, Jr., Carl A. Zierman, Arnold I. Funai, and Alfred Lindahn Washington, NASA, Oct. 1967 115 p refs
(Contract NAS2-2441)
(NASA-CR-907) CFSTI: HC $3.00/MF $0.65 CSCL 20M

The intent of this study is to provide design data on low thermal conductivity insulations, suitable for the elevated temperature and vacuum environment, and analytical predictions of the effects of multidimensional heat transfer on the overall thermal performance of the system. A brief analysis of the one-dimensional heat transfer in multilayer systems is presented together with data on the properties and thermal performance of a number of insulations. Three analytical models are described for studying the multidimensional heat transfer in anisotropic insulations. These are for slab, disc, and cylindrical configurations. Results of parametric studies of the effects of penetrations, exposed edges, and joints on the overall insulation performance are reported, and comparisons are made between the analysis and experimental data for a cylindrical system. Author

N67-39522# Wisconsin Univ., Madison. Mathematics Research Center.
ANGLE OF CONTACT FOR SMOOTH ELASTIC INCLUSIONS
Ben Noble and M. Hussain Apr. 1967 27 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-735; AD-657571)

This paper considers cylindrical and spherical inclusions in an infinite homogeneous isotropic elastic medium under uniform tension. For the two dimensional inclusion, solution of the biharmonic equation leads to dual series relations. For the analogous axisymmetric problem involving a spherical inclusion Boussinesq potentials are used, which lead to dual series relations involving Legendre functions. TAB

N67-39586# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.
EVALUATION OF TWO CYCLIC-STRAIN IMPACT ATTENUATORS
Richard F. Managan, Kenneth C. Flagg, John H. Duddy, and Neville P. Clarke May 1967 23 p ref
(AMRL-TR-66-221; AD-657798)

Two impact energy attenuators operating on the principle of cyclic straining of materials were tested to determine: (1) maximum output accelerations and (2) resultant attenuator deflections. The attenuators were tested in tension with initial impact velocities from 914 to 1338 centimeters per second and maximum input accelerations from 21 G to 58 G. The attenuators were tested in compression with initial impact velocities from 548 to 855 centimeters per second. The maximum output acceleration showed dependency upon payload that was consistent with the attenuator design theory. Author (TAB)

N67-39663*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
VIBRATIONS OF A HOLLOW ELASTIC CYLINDER BONDED TO A THIN CASING OF A DIFFERENT MATERIAL
Vasant S. Kelkar Washington, NASA, Nov. 1967 27 p refs
(NASA-TN-D-4221) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Exact solutions are obtained to determine the natural frequencies and mode shapes of a thin cylindrical shell supported by a hollow core of a different material. Materials for both shell and core are assumed to be homogeneous, isotropic, and linearly elastic. A perfect bond is assumed at the junction of the shell and the core. The composite cylinder is free from stresses at its curved boundaries and is supported by a diaphragm at its flat ends. The solutions for the core are based on three-dimensional elasticity theory and for the shell on bending theory. Curves are plotted to show the variation of the frequency with the variation in circumferential and axial wave numbers and in the ratio of inner to outer radii of the core. Author

N67-39678*# Pennsylvania State Univ., University Park.
SOME ASPECTS OF THE DEFORMATION OF A NEO–HOOKEAN MATERIAL IN COMPRESSION Interim Report
D. Thompson and M. G. Sharma Jul. 1967 100 p refs
(Contracts NAS7-100; JPL-950875)
(NASA-CR-89586; TR-5; IR-2) CFSTI: $3.00 CSCL 20K

Experiments were conducted by compressing, uniaxially, a series of cylinders of length to diameter ratio of two. The boundary conditions at the ends of the cylinders were varied with respect to the amount of friction present. The cylinders were cast of Solithane 113, a rubber-like material. The compressive stresses applied varied from 0 to 19.1 lb/in^2, for stresses which were based on the original cross-sectional area. Strains were measured on the surfaces of the cylinders, which corresponded to ten different values of applied stress. Strain was measured in the axial and circumferential directions by using the moiré fringe method. A short series of tension experiments were also conducted in order to verify the accuracy of the moiré fringe method as employed for this presentation. A theoretical analysis was performed. The classical elastic solution to the problem of uniaxial compression of a cylinder has been done and is presented here in detail. A short review of the finite deformation of a cylinder of Neo–Hookean material under uniaxial compression which produces bulging is given. Author

N67-39697# California Inst. of Tech., Pasadena. Div. of Engineering and Applied Science.
TRANSIENT NON-AXISYMMETRIC WAVES IN TRANSVERSELY ISOTROPIC ELASTIC PLATES
Richard A. Scott and Julius Miklowitz Aug. 1967 24 p refs
(Contract Nonr-220(57))
(TR-6; AD-656097)

Using the equations of motion from linear elasticity, the formal solutions to a class of non-axisymmetric wave propagation problems involving a transversely isotropic plate are obtained. Inversion, on the epicentral axis and for a certain class of materials, is carried out explicitly for the particular problem of the application of a point shear load, with a ramp time-dependence, to one face of the plate, and the results are analyzed numerically for several anisotropic and isotropic solids. Author (TAB)

N67-39700# California Inst. of Tech., Pasadena. Div. of Engineering and Applied Science.

ON SOLVING ELASTIC WAVEGUIDE PROBLEMS INVOLVING NON-MIXED EDGE CONDITIONS

Julius Miklowitz Aug. 1967 44 p refs

(Contract Nonr-220(57))

(TR-5; AD-658145)

Within the framework of the exact linear theory an important class of wave propagation problems in elastic waveguides, involving non-mixed edge conditions (like stress or displacement), have remained unsolved. Basically, this is because known separation methods (classical or integral transforms) do not ask in a natural way for the given edge information. A means for solving some problems in this class, focused on the semi-infinite plate, as an example, is presented here. In the method a Laplace transform is used on the propagation coordinate, say x. Exploitation of the boundedness condition on the solution, at x to infinity, generates two coupled integral equations for the edge unknowns (displacements and strains), which depend, parametrically, on those complex wave number roots of the governing Rayleigh-Lamb frequency equation representing unbounded waves. Solution of these equations determines the transformed solution of the problem, which can be inverted through known techniques. Excitation of a plate with a built-in edge is treated as an example. Author (TAB)

N67-39728# Oklahoma State Univ., Stillwater. School of Mechanical Engineering.

THE BIHARMONIC BOUNDARY VALVE PROBLEM AS APPLIED TO A MEMBRANE HAVING IRREGULAR SHAPE Final Report

Raymond E. Chapel and Howard W. Smith (Boeing Co., Wichita, Kan.) 18 Aug. 1967 70 p refs

(Grant AF-AFOSR-1153-66)

(OSU-AS-67-F-5; AFOSR-67-1768; AD-658464)

A two-dimensional linear elastostatic boundary value problem is formulated for a web having irregular shape. The stresses in the interior of the region are found by obtaining the Airy function then taking second partial derivatives. Finite-difference numerical techniques used by British authors are used except that the simultaneous equations are solved directly instead of using relaxation methods. With the aid of the irregular biharmonic star operator, the equations are written in matrix notation and solved with digital computing equipment. An aluminum alloy semi-monocoque shell structure, fitted with electric resistance strain gages, is loaded statically. Data taken from these experiments are compared to the theoretical values. Ancillary information involving ultrasonic, optical, photostress, and brittle lacquer experiments are briefly described. A coarse (1 in square) and a fine (1/2 in square) grid was formulated for two variations of slope equations. Theoretical-to-experimental stress comparison show nearly perfect agreement for centrally located nodes for all 4 variations of theory. Maximum dispersion occurs in sigma sub yy at the boundary adjacent to the vertical shear load transfer member. Author (TAB)

N67-39768# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

THERMAL STRESSES IN FINITE LENGTH SANDWICH CYLINDERS

Robert M. Rivello Mar. 1967 48 p refs

(Contract NOw-62-0604-c)

(TG-903; AD-656887)

A method was developed for computing the thermal stresses in a finite length sandwich cylinder with thin faces and an isotropic core. The theory, which includes the effects of longitudinal, radial, and shear rigidity of the core, treats the faces as membranes and assumes that the longitudinal and radial displacements in the core vary linearly between the face displacements. The governing equations are derived by the variational method of using the stationary value of the total potential. These equations are solved by the finite-difference method. The analysis has been programmed for the IBM 7094 computer. A brief outline of the program is given, and the input and output formats are described. The results of three check problems are given. These results indicate that the program gives reliable results for a wide range of radii and core moduli. The results of a limited parameter study to determine the effects that length, radius, and core modulus have upon the thermal stresses are given and discussed. Author (TAB)

N67-39771# Fabric Research Labs., Inc., Dedham, Mass.

STRESS–STRAIN RESPONSE OF FABRICS UNDER TWO-DIMENSIONAL LOADING

W. Denney Freeston, Jr., Milton M. Platt, and Meredith M. Schoppee Wright-Patterson AFB, Ohio. AF Mater. Lab., Jul. 1967 92 p refs Sponsored by the AF

(AFML-TR-67-44; AD-658870)

A theoretical analysis of the load-elongation behavior of idealized plain-weave fabrics subjected to biaxial stresses is presented. Fabric strains resulting from both crimp interchange and yarn extension are considered. The analytical expressions derived have been solved with the aid of a digital computer for both linearly elastic and elasto-plastic materials. Time effects, although not explicitly included, are discussed. Generalized plots of the results are presented for the two extremes of initial fabric structure: (1) equal crimp distribution in both sets of yarns; (2) one set of yarns noncrimped-straight. The predicted and measured response of model fabrics are compared. Author (TAB)

N67-39773# ITT Research Inst., Chicago, Ill. Dept. of Mechanics.

SHAKEDOWN INTERACTION CURVE FOR A CIRCULAR ARCH

Philip G. Hodge, Jr. and A. J. Kalinowski Aug. 1967 34 p refs

(Contract Nonr-1406(04))

(DOMIIT-1-36; AD-658504)

A shakedown interaction curve is obtained for a simply supported sandwich arch subject to a central concentrated load and a symmetrically applied edge couple where both loads are allowed to vary arbitrarily between independently prescribed limits. The solution is obtained exactly from below and is used as a reference solution against which an upper bound technique is investigated. Author (TAB)

N67-39783# Stevens Inst. of Tech., Hoboken, N. J. Davidson Lab.

LINEAR DAMPING CHARACTERISTICS OF OSCILLATING RECTANGULAR FLAT PLATES AND THEIR EFFECT ON A CYLINDRICAL FLOAT IN WAVES

Charles J. Henry Jun. 1967 21 p refs

(Contracts NOw-65-0314; N600(19)62900)

(R-1183; AD-657636)

The linear viscous-drag coefficients of rectangular flat plates oscillating in the direction normal to their plane surfaces were obtained from experiments over a range of frequency and aspect ratio, with holes of various numbers and sizes cut in the plates. The effect of the number of holes on the drag coefficient is not as significant as the solidity and the aspect ratio. A solidity of 0.8, together with aspect ratios 1 or 2, seems to give the highest value of drag coefficient. A cursory study of the wave exciting force on a plate-float combination indicates that the added-mass force on the plate tends to cancel the bouyant force on the float. The canceling effect of the plate can be controlled by its size and

depth of submersion, so that it seems feasible to find a plate-float combination together with a float support configuration which will tend to minimize the motions of a vehicle floating in a specified seaway. Author (TAB)

N67-39801# Royal Aircraft Establishment, Farnborough (England).
A TRIANGULAR EQUILIBRIUM ELEMENT WITH LINEARLY VARYING BENDING MOMENTS FOR PLATE BENDING PROBLEMS
L. S. D. Morley May 1967 21 p refs
(RAE-TR-67110; AD-657681)

Work on the finite element analysis of flat plates in bending has previously been directed towards elements which satisfy kinematic conditions between the adjacent elements. The purpose of the paper is to provide the main details of a triangular element which satisfies equilibrium conditions between the adjacent elements. Author (TAB)

N67-39873# Universidad Nacional de Colombia, Bogota. Facultad de Ciencias.
NOMOGRAMS FOR THE DESIGN AND REVISION OF ELEMENTS OF REINFORCED CONCRETE (ELASTIC THEORY) [NOMOGRAMAS PARA EL DISENO Y REVISION DE ELEMENTOS DE CONCRETO ARMADO (TEORIA ELASTICA)]
Eduardo A. Caro Cayzedo *In its* Nomograph Seminar 1967 p 35–46 (See N67-39870 24-19)

A series of nomograms of linear points were constructed for the solution of formulas used in the design and revision of reinforced concrete structures for buildings. The series, of which a few examples are given, consisted of 60 nomograms. These were later reduced to 50 and divided into three groups: the first for slabs, beams, and columns; the second for the definitive design of these same elements; and the third for the revision or verification of this same design. Transl. by R.N.A.

N67-39878# Universidad Nacional de Colombia, Bogota. Facultad de Ciencias.
NOMOGRAM FOR CALCULATING STONE SLABS WITHOUT "FLAT SLAB" BEAMS [NOMOGRAMA PARA CALCULAR LOSES SIN VIGAS "FLAT SLAB"]
Carlos Neira *In its* Nomograph Seminar 1967 p 75–78 (See N67-39870 24-19)

The equations and calculations used to construct a nomogram for determining thicknesses of flat concrete slabs are presented. Transl. by R.N.A.

N67-39904# Polytechnic Inst. of Brooklyn, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.
ASYMPTOTIC SOLUTION FOR SHORT RING-REINFORCED OVAL CYLINDERS
Neil B. Nissel and William P. Vafakos Aug. 1967 47 p refs
(Contract Nonr-839(39))
(PIBAL-928; AD-658516)

An asymptotic expansion procedure is applied to the analysis of a typical bay in a hydrostatically loaded, ring-reinforced, non-circular cylinder. The existence of two distinct characteristic lengths is used in the construction of two asymptotic series which, when combined, form the total solution. The procedure is similar to that proposed by E. Reissner for circular cylinders. The leading terms in the expansions for all stress resultants and deflections are obtained explicitly, and numerical results are compared to available theoretical and experimental data. Author (TAB)

N67-39914*# California Inst. of Tech., Pasadena.
AN EXPERIMENTAL INVESTIGATION OF THE RADIAL DISPLACEMENTS OF A THIN-WALLED CYLINDER
D. G. S. Ricardo Washington, NASA, Nov. 1967 51 p refs
(Grant NsG-18-59)
(NASA-CR-934; SM-67-7) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A series of experiments have been carried out in order to determine the behavior of the wall of a circular cylinder loaded in axial compression. One case considered was when the wall was subjected to an initial displacement by a point radial load. A second case measured wall displacements with no side loads or initial displacements and the third case considered the change in an initial permanent deformation in the thin wall of the cylinder. The data obtained indicate the behavior of such cylinders near the collapse load. Author

N67-39937*# Astro Research Corp., Santa Barbara, Calif.
PRESSURIZED STRUCTURES OF HIGH MOBILITY
A. C. Kyser and H. Schuerch 22 Sep. 1966 25 p refs
(Contract NAS7-427)
(NASA-CR-89786; ARC-R-221) CFSTI: $3.00 CSCL 20K

A method is presented for constructing a cylinder having low bending stiffness and zero restoring moment from the bent condition throughout a wide range of bending deformations. The behavior of the structural mechanism which carries the pressure load and accommodates the bending is described and possible applications to space suit components are shown. Author

N67-39941# Brown Univ., Providence, R. I. Engineering Div.
THE SEPARATION OF MEMBRANE AND BENDING SHEARS IN SHELLS WITH TWO BIREFRINGENT COATINGS
W. Schumann, C. Mylonas, and R. Bucci Jun. 1967 83 p refs
(Contracts DA-19-020-ORD-4674; ARPA SD-86; Grant NSF G-20259)
(ARPA-E45; AD-657936)

The directions and the differences of the principal membrane and bending stresses at a point of a shell or plate are calculated from the birefringence observed at normal incidence on two birefringent coatings, one on each face of the shell. A unique neutral surface is assumed, which is exact for identical coatings or for identical Poissons ratios in shell and coating. Explicit formulas are obtained with the simplifying approximations of a negligible effect of the rotation of the principal directions and of a linear variation of the magnitude of the principal stress-difference over the finite coating thickness. These assumptions are strictly valid for very thin coatings, but give also reasonably good results for ordinary birefringent coatings. The validity of the derived expressions was checked experimentally in square plates subjected to anticlastic bending and membrane stress of known magnitude at various orientations. Two types of tests were performed. At first (1)* the membrane tension was applied through a series of pins in holes around the perimeters of a plate with relatively thick and optically insensitive coatings. Agreement between observed and calculated birefringence under these unfavorable conditions was reasonably good at the higher loads, but not good enough to permit an accurate inverse calculation of the stress-differences from the observed birefringence. The errors were found to be partly due to the difficulty of applying a true membrane force through pins without introducing any bending. Author (TAB)

N67-40130*# Bell Aerosystems Co., Buffalo, N. Y.
INVESTIGATION OF ADVANCED SPACECRAFT STRUCTURAL DESIGN TECHNOLOGY Final Report

R. A. Gellatly and P. V. Marcal Jul. 1967 106 p refs
(Contract NASw-1344)
(NASA-CR-89637; Rept.-2356-950001) CFSTI: $3.00 CSCL 22B

A technical feasibility study of some of the major problem areas in advanced concepts for spacecraft structural design is presented. Element relationships for two types of doubly-curved shell elements were derived for use in the analysis of the characteristic spacecraft shell structure. A computer program was developed for the analysis of axisymmetric shells for use in the design of tanks and pressure vessels. The technology of heat transfer analysis was reviewed and the potentialities of discrete element methods were examined in detail. Methods of structural optimization were studied and an efficient computer program for the minimum weight design of structures including discrete variables is presented. The inclusion of merit criteria other than weight in optimization procedures is discussed, and future developments in computer technology as applied to structural design are surveyed. Author

N67-40134* Aeronutronic, Newport Beach, Calif. Space and Re-entry Systems.
STRESS AND VIBRATION CHARACTERISTICS OF A PLANETARY ENTRY CAPSULE IN THE LAUNCH CONFIGURATION
Gerald A. Cohen [1967] 183 p refs
(Contract NAS1-5554)
(NASA-CR-66465) CSCL 20K

The stress response to 10 g axial and 5 g lateral inertial loadings and the natural vibration modes of a blunt conical glass fiber sandwich capsule adapted to a boost vehicle through an aluminum conical shell were studied using Novozhilov shell and ring theory. In one case (shell supported) the adapter shell connects to the base of the capsule shell, and in the other case (payload supported) the adapter shell connects to the payload, which is hung from the forward section of the capsule shell. It was found that the shell-supported configurations have larger capsule shell stresses but smaller adapter shell stresses than the payload-supported configurations. As a result of the large kinetic energy associated with axial oscillation of the payload mass, the minimum frequencies (17.1 cps, 18.1 cps) of the shell-supported configurations occur in axisymmetric modes. On the other hand, the minimum frequency (13.1 cps) of the payload-supported configurations occurs in an approximately inextensional mode with two circumferential waves of the capsule shell section aft of the payload ring. Author

N67-40139* National Aeronautics and Space Administration, Washington, D. C.
DETERMINATION OF TWO ELASTIC CONSTANTS OF PLATELIKE BODIES [BESTIMMUNG DER BEIDEN ELASTISCHEN KONSTANTEN VON PLATTENFOERMIGEN KOERPERN]
H. Bergstraesser Oct. 1967 10 p refs Transl. into ENGLISH from Z. Tech. Phys. (Leipzig), no. 8, 1927 p 355–359
(NASA-TT-F-11347) CSCL 20K

Two different experimental setups for bending tests, with a parallel strip in pure bending and a square plate in pure shear, are described, followed by an experimental determination of the elastic area of the bent plate and determination of the two moduli of elasticity. Mathematical formulas and shear diagrams are given to demonstrate that the deformed central area of the plate practically coincides with the theoretical shape of the area. A convenient method is described for determining the moduli of elasticity and rigidity of a sheet metal plate without the use of a testing machine. Author

N67-40148*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
ELASTIC DISPLACEMENTS FOR VARIOUS EDGE-CRACKED PLATE SPECIMENS
Bernard Gross, Ernest Roberts, Jr., and John E. Strawley Washington, NASA, Nov. 1967 14 p refs
(NASA-TN-D-4232) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The relative displacement per unit load of two conjugate points is used as a quantitative indicator of crack extension in plane strain fracture toughness K_{Ic} tests. The necessary displacement data are presented here in dimensionless form for five types of single-edge-crack specimens: three-point bending, pure bending, remote axial tension, and eccentric tension of compact rectangular and tapered varieties. The results were obtained by a boundary collocation method of elastic analysis and are highly precise in themselves. The accuracy with which they apply to actual specimens depends on the extent to which the assumed boundary conditions are equivalent to the actual load distributions. Reasonably good agreement was obtained with three sets of existing experimental data, and this agreement is sufficient for K_{Ic} test purposes. For gauge points located on the specimen edge, the results show low sensitivity to small variations in gauge location. Author

N67-40157* Scientific Translation Service, La Canada, Calif.
EXPERIMENTAL AND THEORETICAL STUDIES OF TRANSONIC PANEL FLUTTER
T. Ishii and M. Yanagizawa Washington, NASA, Oct. 1967 56 p refs Transl. into ENGLISH from the Japanese Report TR-74 (Tokyo), 1964 64 p
(Contract NASw-1496)
(NASA-TT-F-11314; NAL-TR-74) CSCL 20K

The solution of the linearized differential equation of unsteady transonic flow is obtained for arbitrary time dependent motion of thin bodies. The characteristics of the linearized theory are examined from the view point of physical understanding of acoustic wave propagation. Applying this result to the panel flutter problem, the flutter boundary of two-dimensional panels, which are simply supported at the leading and trailing edges, is obtained by the Galerkin method with three modes of analysis. Results are compared with the theoretical results for the low supersonic panel flutter, and experimental results for the panels clamped at the leading and trailing edges. Studies reveal that the critical panel thickness ratio (thickness to length) in transonic flow also remains in the finite (non-zero nor infinite) region. Author

N67-40204*# Grumman Aircraft Engineering Corp., Bethpage, N. Y.
DISCRETE-ELEMENT METHODS FOR THE PLASTIC ANALYSIS OF STRUCTURES
G. Isakson, H. Armen, Jr., and A. Pifko Washington, NASA, Oct. 1967 215 p refs
(Contract NAS1-5040)
(NASA-CR-803; RE-287) CFSTI: HC $3.00/MF $0.65 CSCL 20K

This study deals with the extension of finite-element methods to provide analytical means for determining the failure loads of aeronautical structures. Finite element inelastic stress analysis methods are extended to take into account the Bauschinger effect for biaxial stress states using a plasticity theory based on Ziegler's modification of Prager's kinematic hardening theory. The application of this methodology is made to several structures representative of aeronautical construction. Good correlation is obtained between analytical and experimental results for the strains at the root of a notched plate subjected to load cycling in the plastic range. Finite element buckling methods are also extended to consider plastic buckling using Stowell's formulation for implementing a deformation plasticity theory into the buckling theory. Sample calculations are carried out for the plastic buckling of a flat plate with various geometries and edge conditions. Author

N67-40210# Illinois Univ., Urbana.
A GENERAL PROCEDURE FOR THE ANALYSIS OF ELASTIC AND PLASTIC FRAMEWORKS Progress Report, Jun. 1966–Jul. 1967
Glenn A. Morris and Steven J. Fenves Aug. 1967 178 p refs
Its Structural Res. Series No. 325
(Contract Nonr-1834(03))
(AD-658534)

A general procedure is presented for tracing the load-deflection characteristics of frameworks loaded through the elastic range to the plastic collapse stage. An iterative analysis procedure is employed in which the load-displacement characteristics of the structure are linearized over finite loading increments. Consecutive non-proportional load systems consisting of any arrangement of concentrated member and joint loads are considered. Author (TAB)

N67-40217* Astro Research Corp., Santa Barbara, Calif.
THE SPINNING FILAMENTRY DISK AS A HYPERSONIC DECELERATOR
Richard H. MacNeal and Albert C. Kyser 25 Aug. 1967 49 p refs
(Contract NAS7-427)
(NASA-CR-89684; ARC-R-219) CSCL 22B

By spinning a flexible disk about a central hub, it is possible to erect a surface which is sufficiently stiff to be useful for aerodynamic braking. Such a disk is potentially useful as a reentry decelerator because it can be made relatively large with reasonable weight. If the area is large enough, radiation cooling will keep the surface temperature within tolerable limits without the use of nonstructural thermal-protection materials. A reentry decelerator system called the Rotornet that exploits these possibilities is described. The disk area required for typical manned reentry missions from earth orbit is of the order of one square foot per pound of payload, and the decelerator weight is a few percent of the payload weight. The advantages of such a system are greatest under conditions of long heating pulses (e.g., manned entry at superorbital speeds) or low-density atmosphere such as Mars. The Rotornet is shown to be free from spiral instability with proper mass balance and rotor coning. The rotor disk exhibits travelling-wave panel flutter which can be suppressed by various means. Author

N67-40228*# Astro Research Corp., Santa Barbara, Calif.
DEPLOYMENT MECHANICS FOR AN INFLATABLE TENSION-CONE DECELERATOR
Albert C. Kyser Washington, NASA, Nov. 1967 45 p refs
(Contract NAS1-5605)
(NASA-CR-929; ARC-R-228) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The results of an experimental development of a deployable tension-cone decelerator are presented. The design makes use of an inflatable toroid for the compression-resistant structure in the base of the cone. Toroids of two different slenderness ratios were subjected to radial compressive loads to determine the resistance to buckling and the post-buckling behavior under static loads. Measurements were made of the large deformation bending moment developed by the folding hinge of an inflatable tube. The results of these tests were incorporated in an analysis of the loads on the folded aft ring of a tension-cone decelerator. Finally, deployment tests were made by towing the decelerator underwater and the results were found to correlate reasonably well with the elementary theory. Author

N67-40231# Army Natick Labs., Mass.
ON INEXTENSIONAL VIBRATIONS OF THIN SHELLS
Edward W. Ross, Jr. Jul. 1967 34 p refs
(TR-68-14-OSD; AD-658672)

In this paper, the non-symmetric, free, elastic vibrations of thin domes of revolution are studied. It is assumed that the frequency is low. The asymptotic approximations previously given by the writer are used to estimate the general solution to the shell vibration equations at low frequencies. Approximations for the low natural frequencies and modes are derived systematically under a variety of edge conditions. Low natural frequencies are found only when the edge conditions impose no forces tangent to the shell surface. When the edge is free (and only then) Rayleighs inextensional frequencies are recovered. For certain other edge conditions new natural frequencies are found that are above Rayleighs frequencies but still low compared, e.g., with the lowest membrane frequency. The displacement modes associated with these new frequencies are mostly of inextensional type. The general results are applied to estimate these new frequencies for spherical domes. Author (TAB)

N67-40243# Columbia Univ., New York. Dept. of Civil Engineering and Engineering Mechanics.
INTER-LAMINAR SHEAR STRESS IN SANDWICH BEAMS
R. A. Heller Apr. 1967 33 p refs
(Contract Nonr-266(78))
(TR-33; AD-657857)

The distribution of inter-laminar shear stress in sandwich beams is examined. It is found that in soft cored, three-ply sandwich beams elementary equivalent section theory cannot be used to determine the position of maximum shear. The accuracy of the sandwich relations is experimentally illustrated on laminated beams and wire wound rings. Author (TAB)

N67-40262# Kentucky Univ., Lexington. Dept. of Engineering Mechanics.
THE DYNAMIC ELASTIC–PLASTIC INTERFACE AND RELATED TOPICS
Oscar W. Dillon, Jr. Jun. 1967 42 p refs
(Contract AF 49(638)-1646)
(AFOSR-67-1440; TR-1; AD-658487)

Experimental data for the response in a bar when a plastic deformation wave impinges upon a junction with an elastic material are presented. This is accomplished by using a composite aluminum specimen made by gluing a short annealed (soft) section to a long hard (elastic) one. The short section is ten inches long and therefore strain histories at several points are easily observed by means of wire resistance strain gauges. It is found that there are reflections from the elastic-plastic interface which are in qualitative agreement with the predictions of the strain-rate independent theory. However, the experimental data do differ from this theory in quantitative ways. This discrepancy is due in part to interactions with the material in the response range where it is strain-rate dependent. Author (TAB)

N67-40268# Netherlands Research Centre TNO for Shipbuilding and Navigation, Delft.
EQUATION OF MOTION COEFFICIENTS FOR A PITCHING AND HEAVING DESTROYER MODEL [COEFFICIENTEN DER BEWEGINGSVERGELIJKINGEN VOOR EEN STAMPEND EN DOMPEND MODEL VAN EEN JAGER]
W. E. Smith Jul. 1967 24 p refs
(TDCK-48940; S-2189; Rept.-98-S)

The equation of motion coefficients for a pitching and heaving destroyer model are measured using forced oscillation techniques. The forces due to waves on a constrained model are also measured. The pitch and heave motions in regular long crested head waves

are measured. All coefficients, forces and motions are compared with results obtained from modified strip theory computation. Agreement in all cases is excellent. Author

N67-40305* Princeton Univ., N. J.
GENERALIZED AERODYNAMIC FORCES ON A FLEXIBLE CYLINDRICAL SHELL UNDERGOING TRANSIENT MOTION
E. H. Dowell [1967] 24 p refs
(Grant NGR-31-001-059)
(NASA-CR-89682) CSCL 20K

There are two rather closely related problems involving the motion of a flexible cylindrical shell in a fluid flow which are of current engineering interest. These are the stability of the fluid shell system (shell or panel flutter) and the response of the system to external forces, e.g., response to pressure fluctuations in a turbulent boundary layer. In either case, the determination of the aerodynamic forces due to the shell motion is of interest. Heretofore only the special case of sinusoidal or simple harmonic motion has been treated for both external and internal flow. The more general case of arbitrary time (as well as spatial) dependence of the shell motion is considered. The approach used is analogous to that previously employed for the flat plate. Only the external flow case is treated. Author

N67-40322# Picatinny Arsenal, Dover, N. J. Data Processing Systems Office.
CIRCULAR RING REDUNDANTS
Joseph E. Ray, Muriel L. Slevin, and Robert I. Isakower Sep. 1967 62 p
(DPSO-IR-11; AD-658683)

The use and details of a computer programmed structural analysis of closed circular rings is described. The loading on the ring may be any in-plane combination of moments and forces. Along with the redundant moments, radial shears, and circumferential tensile forces induced by the loading imposed on the ring, the program generates stress components and maximum combined stresses. The output is available in both tabular and graphical form. Author (TAB)

N67-40386# Technion Research and Development Foundation, Ltd., Haifa (Israel).
BUCKLING OF UNSTIFFENED CONICAL SHELLS UNDER COMBINED LOADING
A. Berkovits, J. Singer and T. Weller May 1967 52 p refs Presented at the 1967 SESA Spring Meeting, Ottawa, 16–19 May 1967 /its Paper No. 1241
(Grant AF-EOAR-63-58)
(AD-658815)

An experimental program was conducted in order to determine the family of interaction curves for the buckling of unstiffened conical shells under combined axial compression, torsion, and external or internal pressure. Careful experimental technique permitted many repeated buckling tests on the same aluminum-alloy shell without noticeable damage and yielded reliable interaction curves. Results of combined loading tests are presented and compared with linear theory. Test results show that the interaction curve for compression-torsion-pressure loading is defined by superposition of compression-pressure, torsion-pressure and compression-torsion behavior. Author (TAB)

N67-40408# Atomic Weapons Research Establishment, Aldermaston (England).
A SURVEY OF REPORTS ON EXPERIMENTAL STUDIES OF THE FORCES EXERTED ON MODEL STRUCTURES BY THE WIND AND BY BLAST WAVES
J. E. Uppard May 1967 156 p refs
(AWRE-E-6/67) HMSO: 20s

An extensive bibliography is presented of the work which has been performed in many countries and over a long period of time on the forces exerted by a flow of air, or by blast waves, on model scale structures. Abstracts are given of some of the more important experiments performed under steady flow conditions in wind tunnels and of blast-wave studies performed in shock tubes. Author

N67-40471# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE ACTION OF A VIBRATION LOAD ON POLYMER MATERIALS [O DEYSTVII VIBRATSIONNOY NAGRUZKI NA POLIMERNYYE MATERIALY]
L. A. Galin 28 Feb. 1967 16 p refs Transl. into ENGLISH from Akad. Nauk SSSR Izv. Mekhan. (Moscow), no. 6, 1965 p 53–58
(FTD-HT-67-197; TT-67-62702; AD-658603)

The article investigates the vibration load on a strip of polymer material under plane stress conditions. The applied load varies according to harmonic law, whereby its amplitude is constant. The strip is strained in such a way that its sections remain plane. The article investigates the steady-state regime, where the problem amounts to a certain ordinary nonlinear differential equation that is quadratically integrable. Certain cases of nonsteady-state regimes are also examined, where the strips, which are initially at rest, begin to be subjected to the action of a vibration load. TAB

N67-40477# Institute of Technology, Helsinki (Finland). Lab. of Statics and Bridge Building.
AN ANALYSIS OF PHYSICALLY NONLINEAR STRUCTURES
Martti Mikkola (Ph.D. Thesis) 1966 100 p refs /ts Julkaisu 112 Publ.
CFSTI: $3.00

This study is concerned with statically indeterminate structures in which the material does not follow Hooke's law. The structures are assumed to be linear, and the effect of the displacements produced on the equations of equilibrium is ignored. Both the displacement method and the force method are considered. The derivation of the relevant equations, the equations of equilibrium in the displacement method, and the equations of compatibility in the force method, is based on the principles of virtual displacements and of virtual forces, respectively. For ideally elastic systems, the corresponding energy theorems, the principles of the stationary value of the total potential energy, and of the stationary value of the total complementary potential energy may be used. The relations between the stress resultants and the corresponding deformations of a bar are derived on the basis of the Bernoulli–Navier hypothesis, applying the stress–strain curve of the material for tension and compression. The force method is applied to some redundant structures. For the solution of systems of nonlinear equations, an iteration process is used. The theoretical results are compared with the test results available. Author

N67-40487 Adviesbureau der Genie, The Hague (Netherlands).
SHOCK WAVES IN GRANULAR SUBSTANCES (RELATIONSHIP BETWEEN MICROSCOPIC AND MACROSCOPIC BEHAVIOR OF GRANULAR MATERIAL) [SHOKGOLVEN IN GRANULAIRE SUBSTANTIES (VERBAND TUSSEN MICROSCOPISCH EN MACROSCOPISCH GEDRAG VAN KORRELMATERIAAL)]
R. W. Trense Apr. 1966 57 p In DUTCH
(Rept.-103-A; TDCK-48971)

Presented is a three-dimensional analysis of the stress conditions in particle packing. Proceeding from the static problem, the axial-symmetric stress conditions and directional displacement are analyzed. A summary of applicable formulas is given, and considered is the pressure development of two spheres and two ellipsoids in contact with another. Cubic stacking of spheres and the structural stability of variously packed spheres are treated. Investigated and mathematically determined are also the conditions that result when the pore volume between spheres is filled with water. An examination analogous to the three-dimensional problem covers the packing of cylinders and the resulting mass percentage, pore volume, and structural stiffness. Transl. by K.W.

N67-40502# General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation.

STRESS ANALYSIS OF PERFORATED AND NOTCHED STRIPS BY BOUNDARY COLLOCATION METHOD

T. Slot Jul. 1967 34 p refs
(Contract AT(40-1)-2847)
(GEMP-539) CFSTI: HC $3.00/MF $0.65

A boundary collocation method is described which is used to determine analytically the distribution of elastic stresses and displacements in perforated and notched strips. In materials testing, the method provides a means for the accurate computation of stress or strain in factors and gradients in test specimens of finite length. It was found that long strips with regularly spaced holes or notches under longitudinal tension can be treated as short strips with a single perforation or a pair of notches subjected to uniform extension and long strips with regularly spaced holes in lateral tension can be treated as a short strip with a single hole in tension restrained along the sides. NSA

N67-40507 National Aerospace Lab., Tokyo (Japan).

ON THE NATURAL VIBRATION OF PLATE-BEAM COMBINATION STRUCTURES (I)

Shinichi Koshide, Yoichi Hayashi, and Taketoshi Hanawa 1967 17 p refs In JAPANESE; ENGLISH summary
(NAL-TR-137)

The well-known Rayleigh–Ritz procedure is applied to the analysis of the natural vibration characteristics of plate beam conbined structures: such structures simulate closely the wing–fuselage structure of an airplane or a rocket vehicle. General equations were formulated. Numerical treatment was done for simple cases of the structure which consisted of a beam of uniform cross section and a thin plate of uniform thickness: natural frequencies were computed and the vibrational modes were shown graphically for various values of shape parameters. Experimental verification was performed at the same time; the numerical results obtained by this analysis agreed well with experimental results. Finally, some configurations of the wing–fuselage structure are suggested to which analytical methods of this sort seem to be successfully applied. Author

N67-40509# Polytechnic Inst. of Brooklyn, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.

CREEP STRESS CONCENTRATION AT A CIRCULAR HOLE IN AN INFINITE PLATE

Sharad A. Patel, Michael R. Birnbaum (Ph.D. Thesis), and B. Venkatraman Jul. 1967 56 p refs
(Contract AF 49(638)-1360)
(PIBAL-936; AFOSR-67-1399; AD-658833)

The present report is concerned with the creep problem of stress concentration at holes in thin sheets subjected to loads in their own plane. In particular, the problem of creep stress concentration at a small circular hole in an infinite thin plate subjected to uniaxial tension is analyzed in the first part of the report. The second part is essentially an extension of the preceding analysis to the case when the loading is biaxial and consists of tension and compression. These analyses are based on a creep power law and an analogy between the problem of creep and the corresponding nonlinear elastic problem. The solution of this problem is based on Galerkins method. The stress solutions for some values of the index of the power law are presented. Author (TAB)

N67-40540* California Inst. of Tech., Pasadena. Graduate Aeronautical Labs.

VIBRATION AND DAMPING OF THIN-WALLED CYLINDERS

George A. Watts 1962 36 p refs Sponsored by NASA
(NASA-CR-89749) CSCL 20K

The frequencies of normal modes of free vibration of three cylinders of different thickness were found experimentally. For some of the modes damping was also found. The modes excited were of a single axial half wave and multiple circumferential waves. The shells were geometrically similar except for thickness and were made by electroplating copper on accurately machined wax mandrels. Melting the wax produced shells of very uniform thickness without seams. The modes and frequencies agreed to within 10% of the theoretical values for cylinders with fixed ends, except at small numbers of waves where they agreed more closely with the theoretical values for freely supported ends. The damping factors tended toward a small constant value with increasing numbers of waves above the mode with fundamental frequency, but increased rapidly as the numbers of waves decreased below the fundamental. Author

N67-40553# Southampton Univ. (England). Inst. of Sound and Vibration Research.

STRESSES IN SKIN PANELS SUBJECTED TO RANDOM ACOUSTIC LOADING Final Report, Jul. 1965–Dec. 1966

Brian L. Clarkson Wright-Patterson AFB, Ohio, AF Mater. Lab., Jun. 1967 60 p refs
(Contract AF 61(052)-627)
(AFML-TR-67-199; AD-658846)

The report summarises the fully documented experimental data which is available on the stresses induced in typical aircraft structure by jet noise at take off. The experimental values are compared with a design procedure based on a single degree of freedom analysis and the method is extended for application to control surfaces and to integrally stiffened skin panels. The estimates are generally within a factor of two of the measured values. The relatively new phenomenon of shock cell noise is introduced and a typical result for the variation of r.m.s. stress during take off and climb is discussed. Author (TAB)

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

N67-39399*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CHAMBER SHAPE EFFECTS ON COMBUSTION INSTABILITY
Harry E. Bloomer, John P. Wanhainen, and David W. Vincent Washington, NASA, 1967 20 p refs Presented at the 4th Combust. Conf., Menlo Park, Calif., 2–13 Oct. 1967; Sponsored by the Interagency Chem. Rocket Propulsion Group
(NASA-TM-X-52361) CFSTI: HC$3.00/MF$0.65 CSCL 21B

Earth-storable propellant and a hydrogen–oxygen combination were used to investigate techniques and shapes for suppressing screaming in rocket combustors. Details are given on the testing conditions, and the data are extensively tabulated. The findings are outlined for the following configurations: tapered chambers with concentrated pattern injectors, injector percent radial coverage, contraction ratio, length of chamber sleeve, spiral stepped sleeves, and nozzle shape. N.E.N.

N67-39421# Naval Ordnance Lab., White Oak, Md.
MEASUREMENTS OF HYPERSONIC TURBULENT HEAT TRANSFER ON HIGHLY COOLED CONE
Donald M. Wilson 17 Jul. 1967 62 p refs
(NOLTR-67-24; Aerodynamics Res. Rept.-283; AD-658322)

Turbulent boundary layer heat transfer rates were measured on a thin-walled slender cone at a free-stream Mach number of 5.0. Wall to stagnation temperature ratios from 0.15 to 0.40 were obtained by pre-cooling the model using liquid nitrogen. Tests at a wide range of Reynolds numbers were conducted by varying the tunnel supply pressure; thus providing data for both laminar and mixed laminar-turbulent types of boundary layers. The experimental results obtained were compared with existing theories which predict convective heat transfer coefficients. These comparisons indicate that the data corresponding to a 760R supply temperature verify the predictions of Winkler and Cha; however, data acquired at a supply temperature of 1160R substantiate the predictions of Spalding and Chi. Author (TAB)

N67-39437# Naval Ordnance Lab., White Oak, Md.
NONGRAY RADIATIVE TRANSFER EFFECTS ON THE RADIATING STAGNATION REGION SHOCK LAYER AND STAGNATION POINT HEAT TRANSFER Final Report
John D. Anderson, Jr. 10 Jul. 1967 89 p refs
(NOLTR-67-104; Aerodynamics Res. Rept.-281; AD-658321)

An analysis is presented for the radiative cooling and nongray self-absorption effects on the radiating stagnation region shock layer and heat transfer using approximate nongray step models for the absorption coefficient. The results lend support to the potential use of simple step model absorption coefficients in lieu of detailed spectral variations for making engineering calculations. Author (TAB)

N67-39449 Rolls-Royce, Ltd., Derby (England). Advanced Research Dept.
UNSTEADY COMBUSTION—A SELECT BIBLIOGRAPHY
Robert C. Graham, comp. 24 Aug. 1967 23 p refs
(RR/OH/294)

A bibliography on unsteady combustion in liquid propellant rocket engines is presented. The references cover the period from 1960 to 1966. Entries are arranged alphabetically by author or title where no author could be ascertained. R.N.A.

N67-39472# Florida Univ., Gainesville. Dept. of Aerospace Engineering.
HEAT TRANSFER IN A PLANE INCOMPRESSIBLE LAMINAR JET
Knox Millsaps and Norman L. Soong *In* ARL Blanch Anniv. Vol. 21 Feb. 1967 p 231–245 refs (See N67-39461 24-19)
(Grant NsG-542)

Using the velocity components derived by Bickley from a physical formulation due to Schlichting, the thermal distribution in a plane incompressible laminar jet is determined by reducing the energy equation to an ordinary differential equation by a similarity transformation. The reduced equation is solved in terms of associated Legendre functions for all Prandtl numbers, and solutions are derived for particular Prandtl numbers by elementary methods. Some numerical results are presented. Author

N67-39538# Martin Co., Baltimore, Md. RIAS Div.
ON GREY ABSORPTION COEFFICIENTS IN RADIATIVE TRANSFER Scientific Interim Report
Stephen C. Traugott Aug. 1967 63 p refs
(Contract AF 49(638)-1726)
(RIAS-TR-67-9c; AFOSR-67-2044; AD-658209)

The radiative heat flux and several frequency averaged absorption coefficients were calculated for a plane-parallel radiating gas slab, for a variety of absorption spectra. Both constant temperature and constant temperature gradient are considered. None of the assumptions concerning these coefficients of several recent non-grey models turn out to be verifiable, except at best under more restrictive conditions. With constant temperature, the heat flux is to a good approximation the same function of a single optical depth as in a grey gas. With variable temperature a radiative transfer equation with a common coefficient for both emission and absorption terms becomes meaningless, a separate coefficient should be used for the absorption term. Author (TAB)

N67-39563# California Univ., Berkeley. Coll. of Engineering.
A GENERAL FORMULATION AND SOLUTION OF CHEMICAL RATE EQUATIONS FOR USE IN NON-EQUILIBRIUM COMBUSTION STUDIES
Peteris Purgalis and Robert F. Sawyer Jul. 1967 35 p refs
(Grant AF-AFOSR-1256-67)
(TS-67-2; AFOSR-67-2021; AD-658004)

As part of a study of non-equilibrium combustion related to rocket propulsion, a general formulation and solution of chemical rate equations was developed. Product composition change with time for arbitrarily selected homogeneous gas-phase chemical reactions is calculated. A particular reaction mechanism can be constructed through the selection of elementary reactions. A computer program was developed which translates these elementary reactions into the required reaction rate equations. The solution of these equations for the isothermal case also is described. Additionally, a systematic procedure for the collection, sorting, and use of reaction rate data is presented. Author (TAB)

N67-39685# Atomic Energy Commission Research Establishment, Lucas Heights (Australia).
THE SIMPLIFIED THEORY OF MEASUREMENT OF HEAT TRANSFER COEFFICIENTS WITH TRANSIENT TECHNIQUES
J. A. Hart and E. Szomanski Jul. 1967 17 p refs
(AAEC/E182)

An outline is given of a simplified approach to the theory of transient convective heat transfer. Analytical solutions for some cases of substantial interest in surface heat transfer coefficient measurement are obtained. Comparisons with results of previous workers indicate that this new approach leads to exact solutions. Author

N67-39606# Case Inst. of Tech., Cleveland, Ohio. Engineering Div.

TRANSIENT NATURAL CONVECTION IN A VERTICAL TUBE WITH NON-AXISYMMETRIC WALL TEMPERATURE

Pau-chang Lu and G. S. R. Sarma Jun. 1967 20 p refs

(Contract AF-AFOSR-194-67)

(FTAS/TR-67-18; AFOSR-67-1508; AD-658549)

Izumi has investigated the commencement of the natural convection flow inside of a vertical circular tube. The quasi-incompressible fluid is initially at rest with a uniform temperature the same as the wall temperature. At time T=0, the wall temperature is suddenly changed. With a body force acting in the axial direction, a natural convection flow starts owing to the transient non-uniform temperature field established in the fluid. Izumi only investigated the case where the wall temperature is uniform at all times. In practice, it is more likely to find a change of the wall temperature from the initial uniform value to a new non-uniform distribution. The ensuing flow will no longer be axisymmetric as in Izumi's work. It is our object here to examine such transient non-axisymmetric flows. Author (TAB)

N67-39636# Southwest Center for Advanced Studies, Dallas, Tex.

RADIATION FROM NONISOTHERMAL GASES

Gilbert N. Plass 18 Jun. 1967 23 p refs

(Contract AF 19(628)-5039)

(AFCRL-67-0464; SR-3; AD-657800)

General expressions are derived for the radiance of a nonisothermal gas in terms of the equivalent width of the relevant spectral lines. Any appropriate expression for the equivalent width may be used in these equations taken either from the theory of band models or from exact calculations which use molecular constants. A general expression for the radiance is derived which is based on the Curtis-Godson approximation; this is compared with exact calculations. Radiance calculations for four different temperature distributions are given in order to illustrate the method. Author (TAB)

N67-39683# Marine Engineering Lab., Annapolis, Md.

WIPED FILM CONDENSATION

J. A. Bauman Mar. 1967 38 p refs *Its* Assignment 71-110

(MEL-R&D-505/66; AD-657940)

The advantages of periodic mechanical removal of steam condensate from a condensing surface have been examined experimentally and theoretically, using the theory of Sparrow and Siegel. High time average condensing heat transfer coefficients, hc = 5000 Btu per (hr) (sq ft) (deg F), have been obtained at high heat loadings, Phi = 84,000 Btu per (hr) (sq ft). Prediction of this augmentation, achieved with conventional windshield wiper blades, compares favorably with the measured results. Applications of this principle will require a new concept in condenser configuration, perhaps similar to the hollow cylindrical model used in this study. A design study is being made for a specific shipboard application. Author (TAB)

N67-39690*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

VAPOR-PRESSURE DATA EXTRAPOLATED TO 1000 ATMOSPHERE (1.01 × 10^8 N/m^2) FOR 13 REFRACTORY MATERIALS WITH LOW THERMAL ABSORPTION CROSS SECTIONS

Charles C. Masser Washington, NASA, Oct. 1967 32 p refs

(NASA-TN-D-4147) CFSTI: HC $3.00/MF $0.65 CSCL 20M

With the continual increase of interest in high-temperature technology, knowledge of the vapor pressure of refractory materials is becoming essential. Such is the case in the conceptual studies of nuclear systems such as the liquid-core and gas-core nuclear rockets, where attention must be given to the vapor pressure of the materials used. Existing vapor-pressure data were collected for 13 materials with atmospheric boiling points over 3000°K and thermal absorption cross sections less than 5 barns (5.0×10^{-28} m^2). All the data were discussed and extrapolated to 1000 atmospheres (1.01×10^8 N/m^2); with the addition of an error analysis, a temperature range at a given pressure was calculated to indicate the possible error introduced by scatter in the original data. At 1000 atmospheres (1.01×10^8 N/m^2), the element that has the highest boiling point is tungsten (9340°K), while at the same pressure niobium carbide has the highest boiling point of the compounds (8400°K). Author

N67-39945 Atomic Energy Commission Research Establishment, Lucas Heights (Australia).

RADIAL HEAT TRANSFER AT THE WALL IN PACKED BEDS

B. K. C. Chan and K. R. Lawther May 1967 30 p refs

(AAEC/TM389)

A literature survey indicates that adequate mathematical models are available to study heat transfer in packed beds. However, experimental data have been obtained at low Reynolds numbers only, below 3500. Experimental results are reported for a 7 in. diameter bed packed with 0.489 in. and 0.658 in. diameter glass spheres, with preheated air as the fluid flowing in the bed. Results indicate that the bed-to-wall heat transfer coefficient, h_w, based on the wall temperature and a bulk gas temperature, may be best correlated by the relation $Nu = 2.35\ Re^{0.63}$ to a standard deviation of 11.4% for values between 2,000 and 15,000. Author

N67-39999* Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.

MIXING AND HEAT TRANSFER OF A PARTIALLY IONIZED ARGON JET WITH A COAXIAL FLOW OF COLD HELIUM

David B. Fradkin 1965 110 p refs

(Contracts NASr-216; AF 33(657)-9962)

(NASA-CR-89612; Rept.-729) CSCL 20M

Mixing of a subsonic 1 cm-dia argon airjet with a coaxial flow of cold helium was studied by schlieren photography and by a calorimetric and sampling probe. Enthalpy, velocity, and composition of the mixing fluid were measured at 1 atm for a laminar argon jet with a mass flow of 0.32 g/sec and with exit-plane peak temperature and velocity of 20,000°R and 550 ft/sec, respectively. Effects of cold coaxial helium flow velocities of 0, 0.27, and 2.7 ft/sec on jet mixing characteristics were studied, as was the effect of flow field of argon jet flows from 0.2 to 1.4 g/sec at a fixed coaxial helium velocity of 0.27 ft/sec. Over the laminar flow investigated, the obtained data are in excellent agreement with those for a free argon arcjet mixing with stagnant helium at 1 atm. Principal effect of the controlled ducted flow was to hasten mixing by earlier transition of the arcjet to turbulent flow. At high coaxial flows, the dominant mixing process was still in the inflow of the coaxial gas. M.W.R.

N67-40092* National Aeronautics and Space Administration. Washington, D.C.

THE EFFECT OF THE NUMBER OF ACTIVE NUCLEI ON THE RATE OF HEAT TRANSFER IN LARGE-VOLUME NUCLEATE BOILING [K VOPROSU O VLIYANII CHISLA DEYSTVUYUSHCHIKH TSENTROV PAROOBRAZOVANIYA NA INTENSIVNOST' TEPLOOBMENA PRI PUZYR'KOVOM KIPENII V BOL'SHOM OB'YEME]

G. N. Danilova Oct. 1967 6 p Transl. into ENGLISH from Inzh.-Fiz. Zh. (Moscow), v. 11, no. 3, 1966 p 367–370
(NASA-TT-F-11305) CSCL 20M

Experimental results of determining the temperature difference between a heating surface and boiling Freon-113 as a function of the heat flux and the number of active vaporization nuclei are described. The tests made with F-113 in electrically heated horizontal tubes of different roughness showed that the temperature head depends not only on the heat flux but also on the number of active vaporization nuclei present. A mathematical relation for these factors is derived. Author

N67-40124* Scientific Translation Service, La Canada, Calif.
HEAT EXCHANGE IN THE SUPERCRITICAL REGION DURING THE FLOW OF PIPED CARBONIC ACID AND WATER [TEPLOOBMEN V SVERKHKRITICHESKOY OBLASTI PRI TECHENII UGLEKISLOTY I VODY V TRUBAKH]
Ye. A. Krasnoshchekov and V. S. Protopopov Washington, NASA, Oct. 1967 8 p refs Transl. into ENGLISH from Teploenerg. (Moscow), v. 6, no. 12, 1959 p 26–30
(Contract NASw-1496)
(NASA-TT-F-11335) CSCL 20M

Heat transmission in supercritical regions during turbulent flow of carbonic acid and water in pipes is studied. Experimental data show the effect of variable specific heat, viscosity, and thermal conduction upon heat exchange. Calcium formulas are included. Author

N67-40146*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL STEADY-STATE PERFORMANCE OF A MULTITUBE, CENTRALLY FINNED, POTASSIUM CONDENSING RADIATOR
Orlando A. Gutierrez, Loren W. Acker, and Nick J. Sekas Washington, NASA, Nov. 1967 125 p refs
(NASA-TN-D-4227) CFSTI: $3.00 CSCL 13A

A horizontal, multitube, centrally finned radiator panel was operated as a potassium condenser in a vacuum environment as part of a research program applied to advanced Rankine cycle system components. The stainless steel radiator panel consisted of nine tubes 14 feet long manifolded into common inlet and outlet headers. The potassium condensing radiator was operated at nominal vapor temperatures of 1700°R (944°K), 1810°R (1006°K), and 1890°R (1050°K) at vapor flow rates ranging from 122 to 468 pounds per hour (55 to 212 kg/hr) and with inlet qualities from 0.50 to 0.95. No operational difficulties were encountered. Longitudinal temperature profiles along each of the tubes were measured as a means of determining condensing lengths. Transverse temperature profiles along the surface of tubes and fins were also obtained at three different locations. Condensing lengths and pressure drops were compared with values predicted by the use of a two-dimensional heat transfer analysis of the tube-fin cross section, and by a Martinelli–Lockhart two-phase correlation, respectively. Predicted condensing lengths were 11 to 19 percent shorter than measured values. Author

N67-40181* National Aeronautics and Space Administration, Washington, D. C.
AN INVESTIGATION OF HEAT TRANSFER FROM WALL TO STEAM NEAR THE CRITICAL REGION [ISSLEDOVANIYE TEPLOOTDACHI OT STENKI K PARU VBLIZI KRITICHESKOGO SOSTOYANIYA]
A. A. Armand, N. V. Tarasova, and A. S. Konkov Oct. 1967 12 p refs Transl. into ENGLISH from the book "Teploopmen Pri Vysokikh Teplovykh Nagruzkakh i Drugikh Spetial'nykh Usloviyakh, Sbornik Statei" Gosenergoizdat., Moscow, 1959 p 41–50
(NASA-TT-F-11282) CSCL 20M

Experiments on heat transfer between high-parameter steam and a solid wall of nickel or steel in the supercritical region at 227–260 atm abs are described, with a flow sheet of the testing equipment and diagrams of heat values with regular and superheated steam. Formulas are derived for convective heat transfer in tubes in a turbulent regime, for calculating the heat loss from wall to steam and the fluctuations in wall and steam temperature. Author

N67-40292*# Garrett Corp., Los Angeles, Calif. AiResearch Manufacturing Div.
RESEARCH STUDY ON INSTRUMENT UNIT THERMAL CONDITIONING HEAT SINK CONCEPTS Quarterly Progress Report, 1 Sep.–30 Nov. 1966
D. W. Graumann 19 Dec. 1966 52 p
(Contract NAS8-11291)
(NASA-CR-89618; Rept.-66-1491) CFSTI: HC $3.00/MF $0.65 CSCL 13A

Wick boiler modules were tested to determine the relative performance of rectangular and triangular fins. A test module was designed and fabricated, and testing continued. Vertical and horizontal wicking rate tests were performed. Bench tests were performed on porous plates and a pressure drop correlation was developed. Single module sublimator tests were conducted to determine the performance of various porous plates. Preliminary panel designs were conceived and initial analyses begun. Author

N67-40333# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati.
COVARIANT THERMODYNAMICS
B. Touschek 4 Sep. 1967 6 p refs *Its* Internal Note No. 378
(LNF-67/60) CFSTI: HC $3.00/MF $0.65

In this note an outline is presented of a covariant formulation of statistical mechanics, from which a completely covariant form of thermodynamics can naturally be derived. Author

N67-40349# Lehigh Univ., Bethlehem, Pa. Inst. of Research.
MATHEMATICAL AND EXPERIMENTAL INVESTIGATION OF THERMAL INITIATION OF EXPLOSION Progress Report, 1 Apr.–30 Jun. 1967
George R. Jenkins 13 Jul. 1967 5 p ref
(Contract DA-28-017-AMC-1090(A))
(AD-656757)

A summary is given of studies involving the decomposition of lead azide in the temperature range 210C to 243C. TAB

N67-40388# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EXPERIMENTAL INVESTIGATION OF HEAT EXCHANGE OF FLAT PLATE IN SUPERSONIC RAREFIED GAS FLOW
S. I. Kosterin, Yu. A. Koshmarov, and N. M. Gorskaya 18 Aug. 1967 18 p refs Transl. into ENGLISH from Inzh. Zh. (Moscow), v. 2, no. 2, 1962 p 263–269
(FTD-MT-67-43; AD-659023)

The work is dedicated to experimental investigation of recovery temperature and average coefficients of heat transfer on a flat plate in a supersonic rarefied gas flow at zero angle of attack. Author (TAB)

N67-40438*# Farnham (Frank C.) Co., Philadelphia, Pa.
THE DETERMINATION OF THE THERMODYNAMIC STATE OF RELAXING HYPERSONIC GAS FLOWS BY ELECTRON COLLISION EXCITATION [DIE BESTIMMUNG DES THERMODYNAMISCHEN ZUSTANDES RELAXIERENDER HYPERSONISCHER GASSTROEMUNGEN DURCH ELEKTRONENSTOSSANREGUNG]
K. Buetefisch Washington, NASA, Oct. 1967 30 p refs Transl. into ENGLISH from the German Rept. DLR-PB-66-63
(Contract NASw-1497)
(NASA-TT-F-11258; DLR-PB-66-63) CFSTI: HC $3.00/MF $0.65 CSCL 20M

In order to determine the thermodynamic state of relaxing hypersonic gas flows, besides the static temperature and density, the vibrational temperature must also be measured. After discussing several possible measurement procedures, a method for determining the vibrational temperature with the aid of the electron collision excitation technique via spectroscopy is described. The special arrangement of the equipment makes it possible to seek continuously and simultaneously, besides the local vibrational temperature also the local density as a function of position or for a given position as a function of total pressure or stagnation temperature. Author

N67-40474* Farnham (Frank C.) Co., Philadelphia, Pa.
HEAT EXCHANGE WITH CARBON DIOXIDE ALONG SUPERCRITICAL ISOTHERMS UNDER FREE-CONVECTION CONDITIONS [TEPLOOBMEN S UGLEKISLOTOY VDOL'ZAKRITICHESKIKH IZOTERM PRI SVOBODNOY KONVEKTSII]
V. P. Skirpov and P. I. Potashev Washington, NASA, Oct. 1967 7 p refs Transl. into ENGLISH from Inzh.-Fiz. Zh. (Moscow), v. 5, no. 2, 1962 p 30–34
(Contract NASw-1497)
(NASA-TT-F-11333) CSCL 20M

The coefficient of heat exchange (α) from a thin heated platinum filament placed along the central axis of a vertical cylinder to carbon dioxide flowing inside the cylinder was measured as a function of the temperature (t) and pressure (p) inside the cylinder. The α–t relationship is nonlinear, the measured values of α being much higher than should be expected (e.g., $\alpha = 11{,}300$ kcal/m^2/hr/°C at $t = 31.5°$ and $p = 74.6$ atm.); thus, turbulent convection in the vicinity of the heated filament is indicated. The turbulent nature of the convection was confirmed by visual observations made by projection of the phenomena inside the cylinder on a screen. A sharp maximum in the value of α is observed at $p = 74$ atm. ($t = 31.5°$); the maximum value of α shifts in the direction of higher pressures when the temperature is increased, and at $t = 34.0°$, α_{max} occurs at $p = 78$ atm. Author

N67-40510* Heat Technology Lab., Inc., Huntsville, Ala.
ORBITAL HEATING COMPUTER PROGRAM, VOLUME VI Final Report
19 Sep. 1967 84 p refs
(Contract NAS8-11850)
(NASA-CR-89605; HTL-TR-39, Vol. VI) CSCL 20M

This computer program (written in Fortran IV) permits calculation of the incident solar, planetary, and albedo heating rates to satellites of various shapes in a general trajectory. Trajectory inputs may be made in groups of 1000 time–space points; as many groups as practical for computer time may be used. A subroutine is included which will calculate these time–space points for elliptical orbits of any size and orientation with respect to the planet's coordinate system. Options are given to permit digital or plot output of the incident heating data. The detailed digital output format allows the user to completely analyze the trajectory and heating history of each surface element. Special techniques used to calculate view factors significantly reduces computer time in comparison to existing programs. Author

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

N67-39410# Herner and Co., Washington, D. C.
SYSTEM DESIGN, EVALUATION AND COSTING—IN PLAIN ENGLISH
Saul Herner 1 Mar. 1967 17 p Presented at the ADI Inst. on Inform. Sci., Ohio, 15 Dec. 1966
(Contract AF 49(638)-1424)
(AFOSR-67-1998; AD-657788)

The concepts of system design, evaluation, and costing are among the most often discussed and widely misunderstood in the information field. This report attempts, via case illustrations, to describe and explain the steps and processes involved, so as to take some of the mystery and witchcraft out of systems and to facilitate the return of design and operation of information services to where they rightfully belong: to the people who have the day-to-day job of making them go and perform. Author (TAB)

N67-39492# System Development Corp., Santa Monica, Calif.
COST REPORTING FOR DEVELOPMENT OF INFORMATION PROCESSING SYSTEMS
Edward A. Nelson and Thomas Fleishman Bedford, Mass., AFSC, Electron. Systems Div., 11 Apr. 1967 83 p refs
(Contract AF 19(628-67-C-0132)
(TM-3411/000/00; ESD-TR-67-452; AD-657793)

The report describes a system for the collecting and reporting on data on the resources expended in the production of computer programs. The system is intended to: (1) provide information to facilitate management control during the progress of a computer programming effort; (2) build a data bank from which better cost-estimating relationships and planning tools can be developed; (3) accomplish the above with a minimum of interference with operating personnel. The report was designed to provide sample materials necessary for the implementation of cost reporting in any organization in which computer programming is performed; it includes a description of the steps that constitute the computer programming process, the kinds of personnel who would be involved in the cost-collection and -reporting system, a recommended work flow and suggested forms for use in data collection and reporting, a work breakdown structure for associating costs with activities, and a brief discussion of the relationship of this system with several existing Department of Defense management procedures. TAB

N67-39515# Pennsylvania Univ., Philadelphia.
AN EXPERIMENTAL CHEMICAL INFORMATION AND DATA SYSTEM Status Report, Jan.–Dec. 1966
Clarence T. Van Meter, David Lefkovitz, and Ruth V. Powers Jan. 1967 220 p refs
(Contract DA-18-035-AMC-288(A))
(CIDS-4; AD-657575)

The report describes a chemical information and data system in the form in which it was expected to be available for initial experimentation by Army installations on or about 1 May 1967. The description deals primarily with matters referable to structural chemistry. It discloses those structural features that the system presently utilizes to discriminate among chemical compounds, depicts the assignment of keys to these features, and illustrates the use of these keys in the processing of queries addressed to the system. It also discloses certain types of chemical compounds that require further study before they can be incorporated into the system. The kind of nonstructural information and data planned to be

incorporated for early experimentation are identified. Matters germane to system configuration, programming, and program execution are scheduled for inclusion in a subsequent report. Author (TAB)

N67-39814# Pennsylvania Univ., Philadelphia. Moore School of Electrical Engineering.
THE MOORE SCHOOL INFORMATION SYSTEMS LABORATORY
Morris Rubinoff May 1967 31 p
(Contract AF 49(638)-1421)
(AFOSR-67-1952; AD-657809)

The report briefly describes the goals of the Moore School Information Laboratory which are primarily in the following tasks at the system level: specifications for machine storage of indexer aids, including lists of index items, synonymic equivalences, classification tables, and other semantic tools; organization of disk file storage; study of uses of graphic display. The report also summates the progress made in these tasks. Author (TAB)

N67-39668*# National Aeronautics and Space Administration, Washington, D. C.
NASA'S SPACE SCIENCE AND APPLICATIONS PROGRAM
Homer E. Newell Apr. 1967 209 p Presented to the Comm. on Aeron. and Space Sci., Washington, D. C., 20 Apr. 1967
(NASA-TM-X-60553; EP-47) CFSTI: HC $3.00/MF $0.65 CSCL 05A

This booklet contains information which was prepared by NASA's Office of Space Science and Applications for presentation to the Congress of the United States in the course of the fiscal year 1968 authorization process. Much of the text is directed toward some of the issues raised by the congressional committees. There is a discussion of basic research, its value as a source of knowledge, techniques and skills that go into the development of technology, and practical applications. Also discussed is the importance to the strength, well being, and security of the nation of a continuing level of effort in basic research, of which space research is an important and fruitful component. Author

N67-39756*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
CHRONOLOGY OF WORK STOPPAGES AND RELATED EVENTS, KSC/NASA AND AFETR THROUGH JULY 1965
George V. Hanna, III Oct. 1965 103 p
(NASA-TM-X-60558) CFSTI: HC $3.00/MF $0.65 CSCL 05A

Brief accounts are presented of significant events occurring at or affecting the Kennedy Space Center and the Air Force Eastern Test Range from May 1949 through July 1965. Primary emphasis is directed toward labor disputes and work stoppages at these installations. These chronological accounts are supplemented with: (1) chart summaries of man-days lost due to work stoppages at the installations from July 1956 through July 1965; (2) a list of the prime contractors, subcontractors, and joint effort contractors involved in work stoppages at Patrick Air Force Base, Cape Kennedy, and Merritt Island during the period of the report; and (3) a list of labor organizations identified as having caused or participated in the work stoppages cited. E.C.

N67-39769# Logistics Management Inst., Washington, D. C.
MULTI-YEAR PROCUREMENT AT THE SUBCONTRACTOR LEVEL
Jun. 1967 37 p refs
(Contract ARPA SD-271)
(AD-655815)

The increasing use of multi-year and total package procurement has given rise to the possibility of achieving greater economies by the use of multi-year subcontracts. In addition, prime contracts placed on an annual funding basis, and sole source prime contracts may provide opportunities for price reductions through multi-year subcontracting. The purpose of this task is to (1) investigate industry policies and practices in using multi-year procurement techniques at the subcontract level; (2) identify and analyze DoD policy, fiscal, and contractual impediments, if any, to the use of multi-year subcontracts for both multi-year and non-multi-year prime contracts; (3) identify and analyze any extraordinary risks to both the Government and contractors inherent in multi-year subcontracting; (4) develop criteria for selection and conduct of procurements to test the practicability, and to determine the benefits to the Government of multi-year subcontracting. Author (TAB)

N67-39835# Congress. House. Committee on Government Operations.
SUPPORT SERVICE CONTRACTS
Washington, GPO, 1967 96 p Hearing before a subcomm. of the Comm. on Govt. Operations, 90th Congr., 1st Sess., 21 Jun. 1967

Statements made to a hearing before a subcommittee of the Committee on Government Operations, House of Representatives, regarding engineering and technical support service contracts of the National Aeronautics and Space Administration, are presented. Budgetary and contract operations are reported. L.S.

N67-39935# Harry Diamond Labs., Washington, D. C. Technical Information Office.
MULTIPLE TEST OF ABC METHOD. PART III: MATHEMATICAL MODEL
Werner H. Menden May 1967 39 p refs *Its* Army Tech. Library Improvement Studies Rept.-18
(HDL-TR-1334; AD-658668)

The report suggests a method of constructing a mathematical model for the first test of the ABC Storage and Retrieval Systems and calculates 95-percent confidence intervals for relevance and recall values. Author (TAB)

N67-39982*# National Aeronautics and Space Administration, Washington, D. C.
HISTORY OF AERONAUTICS AND ASTRONAUTICS: A PRELIMINARY BIBLIOGRAPHY
Katherine Murphy Dickson, comp.—Library of Congr. May 1967 123 p refs
(NASA-TM-X-60561; HHR-24) CFSTI: HC $3.00/MF $0.65 CSCL 01B

An annotated bibliographical guide to bibliographies on the history of space exploration is presented. The annotations include the scope and purpose of the work, the author's affiliation and/or reputation, the language of the document, special features, limitations, comparisons with similar works, arrangement, content, form, and time period covered. Author, title, and subject indexes are included. M.G.J.

N67-40038 Joint Publications Research Service, Washington, D. C.
MASTERING THE RICHES OF THE WORLD'S OCEANS
A. A. Yelizarov, V. V. Maslennikov, and N. A. Timofeyev 31 Oct. 1967 13 p Transl. into ENGLISH from Morsk. Sb. (Moscow), no. 5, May 1967 p 33-38
(JPRS-43207; TT-67-33832) CFSTI: $3.00

The mineral and biological resources in the oceans and ways of obtaining them are reviewed. The salts and microelements in the sea water, the ores in deposits on the bottom, and the petroleum and ores beneath the bottom crust are described. Not only fish, but also invertebrate animals and plants are mentioned as sources of food. The energy of the ocean and the interaction of ocean and atmosphere are briefly discussed. The use of bathyscaphs for oceanographic researches are indicated. N.E.N.

N67-40135*# Southeastern State Coll., Durant, Okla. Technology Use Studies Center.
[PROGRAM TO ENHANCE THE TRANSFER OF NEW TECHNOLOGY TO POTENTIAL INDUSTRIAL, GOVERNMENTAL, AND ACADEMIC USERS IN THE OKLAHOMA AREA] Quarterly Status Report, 1 Jul.–30 Sep. 1967
Lee B. Zink Oct. 1967 18 p
(Contract NSR-37-004-006)
(NASA-CR-89593; QSR-10) CFSTI: HC $3.00/MF $0.65 CSCL 05C

Efforts on the technology utilization program during this period were devoted to a peanut drying project and an electrically fired incinerator project. In addition literature searches were conducted to provide consumers with information to solve a variety of problems. These problems included finding information on the maximum noise level under which men can do useful work, lightweight concrete for house or apartment construction, the state-of-the-art in steam curing concrete, methods of human waste disposal, lime and domomite stabilization for roadbeds, and how wedge lights are produced. R.N.A.

N67-40140# Logistics Management Inst., Washington, D. C.
TOTAL PACKAGE PROCUREMENT CONCEPT, SYNTHESIS OF FINDINGS
Jun. 1967 121 p ref
(Contract ARPA SD-271)
(AD-655814)

The Total Package method of procurement offers significant advantages over development-only type contracts for both the Government and industry. Advantages include cost savings, shorter development schedules, design for producibility, long range planning, and from the Government's point of view, increased competition. Disadvantages include greater financial risk, premature program definition, and severe competition and increased proposal expenses from the contractor's point of view. TPP should be applied to operational systems development programs and to smaller programs below the DoD Directive 3200.9 threshold criteria. TPP should not be applied to systems where the technology is rapidly changing and responsive to changing military needs or to systems which require an interface application. There is a greater need for an integrated management information system for TPP programs than there is for development-only programs. The Government should disengage from the contractor in TPP programs, and retain visibility but not control unless program redirection is necessary. On balance, the influential factors of cost, schedule, and system performance in the TPP programs studied tend to support rather than constrain technical innovation. Author (TAB)

N67-40192* Washington Univ., St. Louis, Mo. Economics Dept.
COMPETITION IN HIGH TECHNOLOGY GOVERNMENT MARKETS
Murray L. Weidenbaum Nov. 1967 29 p refs *Its* Working Paper No. 6713
(Grant NsG-342)
(NASA-CR-89597) CSCL 05C

The nature of competition in high technology government markets, notably the Department of Defense and the National Aeronautics and Space Administration, is examined. In the absence of comprehensive information on individual competitions for government contacts, turnover data and concentration ratios are developed as a guide to the extent to which relatively few firms dominate this market area. Analyses of the size distribution of leading government contractors also help to illuminate the nature of the competitors for government contracts. On balance, statements so frequently made concerning the large degree of concentration and monopoly in government procurement are not supported by the data. Author

N67-40227* Bellcomm, Inc., Washington, D. C.
BCMRET—THE BELLCOMM INFORMATION RETRIEVAL SYSTEM
I. G. Levie 7 Aug. 1967 183 p
(Contract NASw-417)
(NASA-CR-89759) CSCL 05B

BCMRET, the Bellcomm Information Retrieval System, has been developed over the past two years to satisfy Bellcomm's need for a generalized information storage and retrieval system. The file generation and file maintenance programs which have been written for BCMRET are general purpose routines. These programs make it possible to use the system not only in the usual applications involving administrative data and document information, but also in applications involving purely numerical, engineering data. BCMRET is capable not only of generating and maintaining a file, but also of gathering statistics, sorting output, and generating final reports for output. Author

N67-40313# Library of Congress, Washington, D. C. Aerospace Technology Div.
FOREIGN SCIENCE BULLETIN, VOLUME 3, NUMBER 9 Monthly Review of Selected Foreign Scientific and Technical Literature
Sep. 1967 69 p refs

Breeze-forecasting methods in general use in the Soviet Union are reviewed, with interest centered on two types: climatological, with forecasts made on the basis of the general climatic characteristics of a given region for a specified period of time; and short-range forecasting, based on the use of weather observations routinely and regularly made at weather stations. A proposed short-range forecasting method is described, which uses only those parameters which can be predicted with adequate accuracy using widely accepted procedures. Another paper discusses the magnetic characteristics peculiar to the overcritical region of ferromagnetic thin films. The experimental results obtained are compared with data from the literature. A survey on Soviet gravimetry is presented, and the book "Geophysical Methods of Investigating Rock Pressure" is reviewed. Several articles dealing with such topics as lasers, power plants, and adaptive systems are cited, and summary information is included on the proceedings of some scientific conferences. M.G.J.

N67-40335* Indiana Univ. Foundation, Bloomington. Aerospace Research Applications Center.
[A PILOT PROGRAM FOR INVESTIGATION OF VARIOUS TECHNIQUES TO ENHANCE THE UTILIZATION OF NEW KNOWLEDGE RELATED TO OR STEMMING FROM AEROSPACE RESEARCH AND TECHNOLOGY] Quarterly Report, Period Ending Sep. 30, 1967
Joseph di Salvo 15 Oct. 1967 24 p
(Contract NASr-162)
(NASA-CR-89779) CSCL 05B

Regional Dissemination Center (RDC) services, personnel organization, and operating expenses are reviewed. A program to increase membership in this information retrieval system through revisions in fees and the offering of trial introductory memberships is evaluated. Brief quarterly activity summaries are given for services performed in the following categories: retrospective searches, custom interest profiles, standard interest profiles, document requests, back-up information requests, and computer information services. E.C.

N67-40391 Mitsubishi Heavy-Industries, Ltd., Nagasaki (Japan).
STUDY ON STACK GAS DIFFUSION
Nobuhiro Ukeguchi, Hiroshi Sakata, Hiroki Okamoto, and Yasuo Ide Aug. 1967 16 p refs
(MITB-010052)

Air pollution has become a big object of public concern with remarkable expansion in industries. The useful and effective control of air pollution can be done not only by technical measures such as removal of pollutants in fuel and smoke, and atmospheric diffusion-dilution of pollutants, but also by estimation and countermeasures for anti-airpollution before construction of factories and works. "Atmospheric diffusion" is of much avail for dilution in smoke and provides the quantitative base for steps against air pollution. In this paper the summaries and typical studies are reported of the theoretical and experimental researches on diffusion ever done in our laboratory. Author

N67-40412*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

DATA MANAGEMENT STUDY, VOLUME 5 Final Report

A. Frank 28 Jul. 1967 109 p refs Prepared for JPL

(Contracts NAS7-100; JPL-951112)

(NASA-CR-89704; VOY-CO-FR, Vol. 5, Final) CFSTI: $3.00 CSCL 05B

Data requirements were established; as were means for preparation, submittal, review and reproduction, distribution, and storage in connection with overall data management for the Voyager project. Basic operational aspects of the Voyager data system were delineated throughout its operational phase, and contractor level information flow and data requirements for Voyager design and acquisition phases were developed. Contractor implementation of selected functions of the system was analyzed, and data requirements and reporting systems for project management control of contractor activities were determined. In connection with contractor data requirements, a 10-step data call study was made that included: (1) data call request, (2) preliminary data item list, (3) data requirements baseline, (4) data item list/user matrix, (5) data requirement descriptions, (6) user flow diagrams, (7) document relationship trees, (8) phasing and frequency charts, (9) subcontractor data requirements, and (10) review and approval. Contractor implementation studies were made, along with a contractor management information study dealing with automatic data processing for project control and a technical performance data study. M.W.R.

N67-40413*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

DATA MANAGEMENT STUDY, VOLUME 5. APPENDIX A: CONTRACTOR DATA PACKAGE TECHNICAL DESCRIPTION AND SYSTEM ENGINEERING (SE) Final Report

W. E. Johnston, D. D. Rossard, L. T. Seaman, B. C. Daniels, and L. M. Bergere 28 Jul. 1967 283 p Prepared for JPL

(Contracts NAS7-100; JPL-951112)

(NASA-CR-89705; VOY-CO-FR, Vol. 5, Append. A) CFSTI: HC $3.00/MF $0.65 CSCL 05B

Overall subsystem, system, equipment, and mission definitions, specifications, and requirements are presented for the design goals, performance, reliability maintainability, transportability, and operational characteristics of the Voyager spacecraft. This contractor data package for technical description and system engineering includes the data item matrix, data requirement descriptions, user flow diagrams, document relationship trees, and frequency phasing charts. In addition to plans, specifications, reports, and drawings, some basic design information recording logbooks and other means for formal documentation of system engineering aspects are included. M.W.R.

N67-40415*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

DATA MANAGEMENT STUDY, VOLUME 5. APPENDIX D: CONTRACTOR DATA PACKAGE CONFIGURATION MANAGEMENT (CM) Final Report

A. W. Morris 28 Jul. 1967 149 p Prepared for JPL

(Contracts NAS7-100; JPL-951112)

(NASA-CR-89708; VOY-CO-FR, Vol. 5, Append. D) CFSTI: HC $3.00/MF $0.65 CSCL 05B

Maintenance of a uniform system of configuration management is covered in this contractor data package, which includes the data item list/user matrix, data requirement descriptions, documentation relationship trees, and data item phasing/frequency. Various lists, indexes, logbooks, procedures, instructions, and reporting forms are included in the data descriptions; and the relationship of data items is shown for each functional category as well as across categories. M.W.R.

N67-40423*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

DATA MANAGEMENT STUDY. APPENDIX L: CONTRACTOR DATA REQUIREMENTS FACILITIES (FA) Final Report

A. T. Christensen and J. H. Behm 28 Jul. 1967 53 p

(Contract NAS7-584)

(NASA-CR-89716; VOY-DC-FR, Append. L) CFSTI: HC $3.00/MF $0.65 CSCL 05B

Data are presented relating to the planning, design, estimating, approval, scheduling construction, inspection, testing, and control of Voyager project facilities; while activation phases of facilities are covered in the appendix dealing with site activation for launch, and overall integration of facilities are treated in either the overall management or scheduling data management reports. The facilities user flow diagram and a documentation relationship tree are included, contractor data requirement descriptions are detailed, and a data item frequency and phasing chart shows the requirements for contractor data item preparation by major project review periods. M.W.R.

N67-40427*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

DATA MANAGEMENT STUDY. APPENDIX P: CONTRACTOR DATA REQUIREMENTS RELATED PROJECT INTERFACES (RP) Final Report

L. A. Binegar and A. W. Morris 28 Jul. 1967 47 p

(Contract NAS7-584)

(NASA-CR-89720; VOY-DC-FR, Append. P) CFSTI: HC $3.00/MF $0.65 CSCL 05B

Technical, administrative, and managerial information documentation is considered for the effects of related space programs on the Voyager project. These contractor data requirements identify plans, procedures, and management and technical techniques for disseminating and considering all related interface criteria. The listed data items reflect the means for a contractor to identify, acquire, and disseminate space information that might have an impact on the Voyager program. Listings are included of relevant subjects and of suggested sources of information. Related project interfaces are shown in a user flow diagram; and data requirement descriptions, a documentation relationship tree, and a data item frequency and phasing chart are included. M.W.R.

N67-40489* Wayne State Univ., Detroit, Mich. Center for Application of Sciences and Technology.

[A PROGRAM TO ACCELERATE THE INDUSTRIAL APPLICATION OF AEROSPACE RELATED TECHNOLOGY] Progress Report, Jan.–Sep. 1967

Hamilton Stillwell Sep. 1967 70 p refs

(Contract NASr-175)

(NASA-CR-89745) CSCL 05A

An overview is presented on the activities of the Center for Application of Sciences and Technology to transfer technology to industry and thereby stimulate and accelerate technological and economic progress. A revised organizational chart is included, and

details are given on the functional assignments. The clients who purchased $50 or more in services are listed, along with statistics on the services and computer searches requested by them. Copies of two dissemination tools are included: the bimonthly "General Awareness Program" publication aimed at interesting prospects in purchasing the available services, and the "Metal Joining Digest" which includes new items, and magazine and technical journal articles on repairs, new materials and machines, and research. M.G.J.

N67-40491# Congress. House. Committee on Science and Astronautics.
INTERNATIONAL BIOLOGICAL PROGRAM
Washington, GPO, 1967 452 p Hearings before the Subcomm. on Sci., Res., and Develop. of the Comm. on Sci. and Astronautics, 90th Congr., 1st Sess., 9 May, 6 Jun., 12 Jul., 3 and 9 Aug. 1967

The full text of statements are presented in support of a Congressional resolution urging public and private support of the International Biological Program. It is pointed out that such a program offers a unique and effective means of meeting the urgent need for increased study and research related to biological productivity and human welfare in a changing world environment. Overall planning and coordination programs are discussed. Additional data are presented on such projects as atmospheric dispersal of biologically significant material, Hawaiian terrestrial biology, analysis of drainage basins and landscapes, conservation of ecosystems, use and management of biological resources, productivity of freshwater and terrestrial communities, production processes, productivity of marine communities, human adaptability, systematics and biogeography, environmental physiology, tropical biology, and the ecology of man. M.G.J.

N67-40495*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
CHRONOLOGY OF WORK STOPPAGES AND RELATED EVENTS KSC/NASA AND AFETR, JULY 1965–JULY 1967
William Z. Schenck 1 Aug. 1967 25 p
(NASA-TM-X-60556; GP-380) CFSTI: HC $3.00/MF $0.65 CSCL 05I

Statistical data are presented on the man-days lost by construction contractors due to strikes, jurisdictional disputes, and related work stoppage events. A chronology is included which gives the date, the union and contractor involved, the number of employees who walked off the job, the time lost, and the effect such actions had on project completion dates. M.G.J.

N67-40516# Israel Program for Scientific Translations, Ltd., Jerusalem.
HYGIENE EFFECTS AND CONTROL OF DUSTS, FOGS, GASES, VAPORS, RADIOACTIVE PARTICLES
H. Schneider, ed. [1966] 60 p refs Transl. into ENGLISH of Staub (Dusseldorf), v. 26, no. 10, Oct. 1966 Publ. for Dept. of Health, Educ. and Welfare and NSF
(TT-66-51159/10) CFSTI: HC $3.00/MF $0.65

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8. THE SEPARATION OF RADIOIODINE IN RESPIRATORY FILTERS W. Jacobi and J. Hacke (Hahn-Meitner-Inst. für Kernforschung) p 34–39 refs (See N67-40524 24-34)

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N67-40517# Hauptverband der Gewerblichen Berufsgenossenschaften, E. V., Bonn (West Germany). Staubforschungsinstitut.
POSSIBILITIES FOR RECORDED DUST MEASUREMENT AND DUST CONTROL
Alfred Schuetz *In* Israel Program for Sci. Transl. Hygiene Effects and Control of Dusts, Fogs, Gases, Vapors, Radioactive Particles [1966] p 1–8 refs (See N67-40516 24-34)

A survey of different methods for recording dust measurements is given. The following methods are discussed in particular: optical methods; extinction and scattered light measurement; nuclear radiation methods; attenuation of β-rays; electrical methods; ion accumulation and contact electricity. The design and mode of the instrumental operations are described. In addition, the relationship between the instrument reading and gravimetric dust concentration is shown, and also the detection sensitivity and the influence of particle size and of material properties. Possibilities of application are discussed. Author

N67-40519# Textil- und Bekleidungsberufsgenossenschaft, Moenchengladbach (West Germany).
DUST MEASUREMENT IN PLANTS WITH ASBESTOS PROCESSING MACHINERY
Arthur Martin Kesting *In* Israel Program for Sci. Transl. Hygiene Effects and Control of Dusts, Fogs, Gases, Vapors, Radioactive Particles [1966] p 14–16 (See N67-40516 24-34)

Systematic measurements of dust concentration were started about 10 years ago in the textile industry in plants with asbestos processing machinery. Observations over longtime periods have given basic data for dust concentrations occurring in the individual processing stages. Statistical evaluation of all results on dust measurements shows that there is a continuous decrease in dangerous dust concentration. The object of further investigations is to find out (by comparing cases of illness caused by asbestos with asbestos dust concentrations) at what concentration and exposure time the danger of illness caused by asbestos is negligible. Author

N67-40520# Hauptverband der Gewerblichen Berufsgendssen-schaften, E. V., Bonn (West Germany). Staubforschungsinstitut.
EVALUATION AND ASSESSMENT OF DUST MEASUREMENTS IN ASBESTOS PLANTS OF THE TEXTILE INDUSTRY
Erwin Walter *In* Israel Program for Sci. Transl. Hygiene Effects and Control of Dusts, Fogs, Gases, Vapors, Radioactive Particles [1966] p 16–19 refs (See N67-40516 24-34)

The konimeter measurements carried out over 15 years in asbestos plants of the textile industry, and their classification

according to microphotographic tests give an accurate picture of the situation in regard to dust concentration. Gravimetric measurements give an average value; they can also be used for an assessment by coefficients. There is a limited relationship between the values measured by filtering instruments and those obtained by konimeter. This is particularly valid when the dust concentration lies below the danger limit. Author

N67-40521# Kahnwald (Helmut), Duesseldorf (West Germany).
DUST MEASUREMENTS IN FLOWING GASES
Helmut Kahnwald *In* Israel Program for Sci. Transl. Hygiene Effects and Control of Dusts, Fogs, Gases, Vapors, Radioactive Particles [1966] p 20–22 refs (See N67-40516 24-34)

Values of dust content x_t measured in a production plant vary during an operating time t by a function $X(t)$. Therefore, to determine the dust emission accurately the dust measurement must be carried out at intervals as short as possible. When a sufficient number of measured values is available, the probable course of function $X(t)$ for dust emission must be determined by probability calculus. The starting point is here the theory of random processes and a distinction is made between continuous and discontinuous processes. Author

N67-40522# Hauptverband der Gewerblichen Berufsgenossenschaften, E. V., Bonn (West Germany). Staubforschungsinstitut.
WHAT MAY BE DEMANDED OF HIGH EFFICIENCY FILTERS?
Dieter Hasenlever *In* Israel Program for Sci. Transl. Hygiene Effects and Control of Dusts, Fogs, Gases, Vapors, Radioactive Particles [1966] p 22–26 refs (See N67-40516 24-34)

The author shows cases requiring the use of high-efficiency filters and discusses problems associated with their operation. He gives a survey of results obtained in Germany after testing high-efficiency mechanical filters (absolute filters) for a period of three years. According to these results 63.3% of fibre filters subjected to tests satisfied the requirements. The permeability of large filters in nuclear plants can, however, be several times higher than of a single filter element or of the filter material used. This is due to the fact that in many cases there are leaks between the filter elements and filter housing. Methods are given for reducing these leaks, which frequently cannot be controlled, by essentially shortening the sealing line. Author

N67-40523# Atomic Energy Commission, Washington, D. C. Div. of Operational Safety.
FILTRATION PROBLEMS IN THE A.E.C. PROGRAM
Humphrey Gilbert *In* Israel Program for Sci. Transl. Hygiene Effects and Control of Dusts, Fogs, Gases, Vapors, Radioactive Particles [1966] p 27–33 refs (See N67-40516 24-34)

Large air-cleaning plants of the U.S. Atomic Energy Program are described and illustrated by photographs. The practical experience of the A.E.C. gained in other nuclear and non-nuclear air-cleaning plants requiring high-efficiency filters, is discussed in detail. The asbestos-cellulose filter and glass fiber filter are compared with regard to their efficiency and cost in the U.S.A. Author

N67-40524# Hahn-Meitner-Institut fur Kernforschung, Berlin (West Germany).
THE SEPARATION OF RADIOIODINE IN RESPIRATORY FILTERS
Wolfgang Jacobi and Juergen Hacke *In* Israel Program for Sci. Transl. Hygiene Effects and Control of Dusts, Fogs, Gases, Vapors, Radioactive Particles [1966] p 34–39 refs (See N67-40516 24-34)

The deposition of radioiodine in the filter and both its constituents (fibrous filter and charcoal filter) was studied by the multiple-filter-method. By this method the different iodine components in the air could be separated and their fractions determined. Elemental iodine, as well as iodine attached to aerosols, are effectively retained in the filter system. For a third, weak component, which probably is mainly methyliodide, the filter is rather penetrable. The fraction of this component in air decreased inversely proportional to the iodine concentration in air and was about 0.03% for a specific J^{132} activity of 10^{-4} Ci/m^3. The corresponding total J-permeability through the filter is about 0.02%. Author

N67-40525# Kernforschungsanlage, Juelich (West Germany).
TESTING AEROSOL FILTERS FOR FACTORY AND TRANSPORT DAMAGE AND PRACTICAL EXPERIENCE WITH VENTILATING UNITS IN LABORATORIES WITH RADIOACTIVE WASTE AIR
Jan Stratman *In* Israel Program for Sci. Transl. Hygiene Effects and Control of Dusts, Fogs, Gases, Vapors, Radioactive Particles [1966] p 39–42 (See N67-40516 24-34)

The testing of high-efficiency filters by means of an "oil-thread test" is discussed. The kind of damages appearing most frequently at fabrication and transport are determined. Also reported are the problems incident in installation and removal of high-efficiency filters and the applicability of high-efficiency filter boxes. Author

N67-40532*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
DATA MANAGEMENT STUDY. APPENDIX Q: CONTRACTOR DATA REQUIREMENTS ADVANCED MISSIONS (AM) Final Report
W. J. Roths and J. H. Behm 28 Jul. 1967 53 p
(Contract NAS7-584)
(NASA-CR-89721; VOY-DC-FR, Append. Q) CFSTI: HC $3.00/MF $0.65 CSCL 05B

These data relate to advanced missions and potential follow-on programs of the Voyager project and are an aid in planning and applying all Voyager-generated data to extended capability programs. Data items include specifications, plans, and reports required to plan, control review, and report advanced mission activities during design, development, manufacture, and testing of the 1973 spacecraft. Contractor–user flow diagrams are given which show the relationship between Voyager system documentation and the activities of the prime spacecraft contractor. The diagrams are a communication tool describing the project in terms emphasizing documentation, and a planning tool for the integration of data management into the overall project management. Subsystems and components are each treated as collective entities, and the documentation flows associated with the several separate subsystems are not distinguished. Detail activities are shown in drawings, and a generalized summary flow is presented. Also included are a documentation relationship tree and a data item frequency and phasing chart showing contractor data item preparation requirements by major project review periods. K.W.

N67-40547# Congress. House. Committee on Government Operations.
BETTER MANAGEMENT OF RESEARCH EQUIPMENT PROCUREMENT AND UTILIZATION IN FEDERAL LABORATORIES
Washington, GPO, 1967 20 p refs 15th Report by the Comm. on Govt. Operations, 90th Congr., 1st Sess., 30 Oct. 1967

Attention is given to the huge scale and rising costs of Federal laboratory operations that require special management and continued improvement in a report by the Committee on Government Operations for the Committee of the Whole on the State of the Union to the 90th Congress. Both the difficulty in controlling the costs of laboratory equipment and inefficient

management are noted, and emphasis is placed on the fact that greater economy and efficiency can be attained. The Brookhaven offer-of-sale procurement method, the U.S. Army Natick Laboratories' use of elapsed-time meters to establish equipment utilization, Goddard Space Flight Center's walk-through technique for identifying idle equipment, and equipment pools are mentioned as means to achieve better utilization. M.W.R.

N67-40578# Lockheed Missiles and Space Co., Palo Alto, Calif. Electronic Sciences Lab.

AUTOMATIC INDEXING AND ABSTRACTING Annual Report

Mar. 1967 118 p refs

(Contract Nonr-4440(00))

(M-21-67-1; AD-659057)

The investigation is concerned with the development of automatic indexing, abstracting, and extracting systems. Basic investigations in English morphology, phonetics, and syntax are pursued as necessary means to this end. In the first section the theory and design of the sentence dictionary experiment in automatic extraction is outlined. Some of the computer programs needed for this experiment have been completed; documentation for these programs is included. The second section is a discussion of an unconventional information retrieval system which may be used to retrieve English or Russian technical literature. Specifically, there is a discussion of the query language and of the data base structure. The design of this system is complete and programming has begun. The third section comprises a final report in an exhaustive study of the relation between the orthographic and phonetic forms of English monosyllables. The paper reports on the methods and accuracy of the algorithm to map the orthographic forms of English into the phonetic forms given by five different phonetic authorities, or to map the phonetic form given by one authority into that given by another. Author (TAB)

N67-40585# Public Health Service, Washington, D. C.

THE THIRD NATIONAL CONFERENCE ON AIR POLLUTION

[1967] 883 p refs Proc. held in Washington, D. C., 12–14 Dec. 1966

GPO: $4.25

These proceedings of the 1966 conference contain several general presentations on the subject of air pollution as well as numerous presentations on specific aspects of the problem. The articles are arranged according to the following subject categories: (1) motor vehicles; (2) heat and power generation; (3) industrial operations; (4) solid waste disposal; (5) state and interstate air pollution control programs; (6) local or regional air pollution control programs; (7) role of the Federal government in air pollution control; and (8) economic and social aspects of air pollution control. Summarizing panel reports on these subject categories are included. K.W.

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—NATIONAL AERONAUTICS AND SPACE ACT OF 1958

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